

Before the Hearing Panel
Appointed by the Waimakariri District Council

Under the Resource Management Act 1991

In the matter of a hearing on submissions on the proposed Waimakariri District Plan

Hearing Stream 12: Rezoning

Rachel Claire Hobson and Bernard Whimp

Submission: 179 / Further submission: 90

Evidence of Nicholas Kelvin Harwood

5 March 2024

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**anderson
lloyd.**

Introduction

- 1 My name is Nicholas (Nick) Kelvin Harwood.
- 2 I have completed BEng (Hons) Engineering Geology & Geotechnics, MSc Soil Mechanics & Engineering Seismology, and Diploma of Imperial College.
- 3 I am employed by Eliot Sinclair & Partners Ltd and have held this position since 2015.
- 4 My previous work experience includes over 25 years as a consulting geotechnical engineer in natural hazard risk assessment and land development, with the past 22 years based in New Zealand.
- 5 I have prepared the Geotechnical Assessment Report (**attached** as Appendix A) supporting the submission of Rachel Claire Hobson and Bernard Whimp (**the Submitters**), relating to the following land (**the Site**):
 - (a) 518 Rangiora-Woodend Road, Rangiora;¹ and
 - (b) 4 Golf Links Road, Rangiora.²
- 6 The Submitters seek an extension of the North East Rangiora or South East Rangiora Development Area overlay to include the Site within a Future Development Area (**FDA**); and the rezoning of the Site from Rural to General Residential.
- 7 This evidence provides a brief summary of my attached Geotechnical Assessment Report.

Code of Conduct for Expert Witnesses

- 8 While this is not a hearing before the Environment Court, I confirm that I have read the Code of Conduct for expert witnesses contained in the Environment Court of New Zealand Practice Note 2023 and that I have complied with it when preparing my evidence. Other than when I state I am relying on the advice of another person, this evidence is within my area of expertise. I have not omitted to consider material facts known to me that might alter or detract from the opinions that I express.

¹ Legal description Part Rural Section 1054

² Legal description Lot 2 DP 16884

Summary

- 9 My assessment supports inclusion of the Site within a FDA and the rezoning of Site to General Residential. The details of that assessment are set out in the report attached at Appendix A and are summarised below.
- 10 My scope of works was to:
- (a) review available data from the New Zealand Geotechnical Database³ (NZGD), Canterbury Maps⁴ and the Institute of Geological & Nuclear Sciences' (GNS) Active Faults Database;⁵
 - (b) review the Waimakariri District Council natural hazards maps;⁶
 - (c) undertake a site walkover to identify any possible geotechnical hazards; and
 - (d) undertake cone penetration tests (CPT) and boreholes to characterise the soil profile and assess the liquefaction potential.⁷
- 11 The scope of geotechnical assessment and density of investigation positions required for the purposes of considering the proposed rezoning was determined in liaison with the project's planners and with reference to MBIE/NZGS Module 2: Geotechnical investigations for earthquake engineering (2021)⁸.
- 12 The topography of the Site (approximately 11.3 hectares) is generally flat with some undulations, a climb in elevation towards the north, and two notable channel features. The channels flow from the west and converge at around the centre point of 518 Rangiora Woodend Road. The channel features may be considered as "normally dry" though are part of the WDC mapped overland flow network.⁹
- 13 Geological mapping of the area indicates the site is underlain by river deposits (alluvium). Alluvial ground conditions were proven via an array of deep test positions using CPTs and boreholes.
- 14 The land elevation broadly falls from north to south across the site with an elevation difference of approximately 3m. The groundwater depth data indicates a

³ New Zealand Geotechnical Database (NZGD) - <https://www.nzgd.org.nz/>

⁴ Canterbury Maps - <https://mapviewer.canterburymaps.govt.nz>

⁵ GNS Active Faults Database - <http://maps.gns.cri.nz/website/af/viewer.htm>

⁶ WDC natural hazard maps: <https://letstalk.waimakariri.govt.nz/natural-hazards>

⁷ The scope of geotechnical assessment and density of investigation positions required for the rezoning was determined in liaison with the project's Planners and with reference to MBIE/NZGS Module 2.

⁸ New Zealand Geotechnical Society (NZGS), Module 2 - <https://www.nzgs.org/libraries/earthquake-geotechnical-engineering-module-2-geotechnical-investigations-earthquake-engineering>

⁹ Refer to Eliot Sinclair's Flood Impact Assessment Report for flood modelling details of the site.

compatible trend with a deeper groundwater depth in the north and becoming shallower to the south. At the time of our fieldwork (July & August 2023) the data indicates groundwater depth as approximately 3m towards the north and as shallow as 0.4m in the south. Groundwater level fluctuates seasonably.

- 15 The broad-brush site-specific investigation and assessment of CPT and borehole records determines that equivalent TC2 land performance is generally predicted for the Site for the purposes of the rezoning submission. The MBIE residential development guidance document (Table 3.1) provides the following index criteria for the technical categories:

Table 3.1: Index criteria for foundation technical categories

Foundation Technical Category	Future land performance expectation from liquefaction	Nominal SLS land settlement	Nominal ULS land settlement	Nominal Lateral Stretch
TC1 (where confirmed)	Liquefaction damage is unlikely in a future large earthquake	0–15 mm	0–25 mm	Generally not expected
TC2 (where confirmed)	Liquefaction damage is possible in a future large earthquake	0–50 mm	0–100 mm	<50 mm
TC3 (where confirmed)	Liquefaction damage is possible in a future large earthquake	>50 mm	>100 mm	>50 mm

- 16 The MBIE guidance (Section 1.4.3) states: “TC2: Liquefaction damage is possible in future large earthquakes. Standard enhanced foundation repair and rebuild options in accordance with MBIE guidance are suitable to mitigate against this possibility.”

Conclusions

- 17 Geotechnical hazards can be mitigated through good development design and construction practice to ensure the safety of infrastructure, buildings and people.
- 18 There are no special conditions warranting geotechnical risk management measures beyond those that fall within normal infrastructure and building investigation and design practices.
- 19 I conclude that the Site is suitable for rezoning from rural to residential land use from a geotechnical perspective.

Dated 5 March 2024

Nicholas Kelvin Harwood



Geotechnical Assessment Report

Version A

**518 Rangiora Woodend Road & 4 Golf
Links Road, Rangiora**

Prepared for CVI Projects Ltd

511185

**eliot
sinclair**

Geotechnical Assessment Report

518 Rangiora Woodend Road & 4 Golf Links
Road, Rangiora

Prepared for CVI Projects Ltd

511185

Quality Control Certificate

Eliot Sinclair & Partners Limited

eliotsinclair.co.nz

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Contents

1. Introduction	1
2. Scope of Works	1
4. Existing Data Review	3
4.1. Geology	3
4.2. Active Faults	3
4.3. MBIE Technical Categories	3
4.4. Listed Land Use Register Records	3
4.5. Nearby Geotechnical Data	3
5. Geotechnical Site Investigation	4
5.1. Scope	4
5.2. Cone Penetration Testing	4
5.3. Sonic Core Borehole Drilling Testing	5
5.4. Groundwater Depth	6
6. Liquefaction Hazard Assessment	7
6.1. Assessment Methods	7
6.2. CPT-Based Liquefaction Assessment	8
6.3. SPT-Based Liquefaction Assessment	9
6.4. Lateral deformation hazard	9
6.5. Site-Specific Technical Category	9
7. Natural Hazard Risk Assessment	11
7.1. Introduction	11
7.2. Earthquake Shaking	11
7.3. Flooding	12
7.4. Liquefaction Vulnerability Mapping	13
7.5. Erosion and Subsidence	14
8. Conclusions	14
9. Proposed District Plan Rules	14
10. Disclaimer	15

- Appendix A. Nearby Borehole and Well Records**
- Appendix B. McMillan CPT Testing Records**
- Appendix C. Pro-drill Borehole Drilling Testing Records**
- Appendix D. CPT Based-Liquefaction Analysis Report**
- Appendix E. SPT Based-Liquefaction Analysis Report**

1. Introduction

Eliot Sinclair & Partners Ltd was engaged by CVI Projects Limited to compile a Geotechnical Assessment to confirm the suitability for rezoning from rural to residential land use of the site at 518 Rangiora Woodend Road and 4 Golf Links Road, Rangiora.

This report is intended to be used as technical supporting documentation to support the submission requesting site rezoning as part of the Proposed Waimakariri District Plan review.

The scope of geotechnical assessment and density of investigation positions required for the rezoning was determined in liaison with the project's Planners and with reference to MBIE/NZGS Module 2: *Geotechnical investigations for earthquake engineering (2021)*¹. The assessment undertaken is essentially a RMA s106 natural hazards assessment, but using a wider array of investigation positions as per Module 2, Table 2.1.

2. Scope of Works

The scope of work for this report was to:

- Review available data from the New Zealand Geotechnical Database² (NZGD), Canterbury Maps³ and the Institute of Geological & Nuclear Sciences' (GNS) Active Faults Database⁴,
- Review the Waimakariri District Council natural hazards maps⁵,
- Undertake a site walkover to identify any possible geotechnical hazards,
- Undertake Cone Penetrometer Tests (CPTs) to a target depth of 15m bgl below ground level (bgl) or practical refusal to characterise the deep subsurface soil profile, assess the liquefaction potential and future land performance,
- Undertake machine boreholes (BHs) to a target depth of 10m bgl below ground level (bgl) to characterise the nature and deep subsurface soil profile and assist the liquefaction analysis, and
- Prepare a Geotechnical Assessment report to summarise the general geotechnical conditions encountered across the site, comment on risk of liquefaction and assess the future ground performance as evidence for the proposed plan change.

¹ New Zealand Geotechnical Society (NZGS), Module 2 - <https://www.nzgs.org/libraries/earthquake-geotechnical-engineering-module-2-geotechnical-investigations-earthquake-engineering/>

² New Zealand Geotechnical Database (NZGD) - <https://www.nzgd.org.nz/>

³ Canterbury Maps - <https://mapviewer.canterburymaps.govt.nz>

⁴ GNS Active Faults Database - <http://maps.gns.cri.nz/website/af/viewer.htm>

⁵ WDC natural hazard maps: <https://letstalk.waimakariri.govt.nz/natural-hazards>

3. Site Description

The site located at 518 Rangiora Woodend Road and 4 Golf Links Road, Rangiora comprises a total land area of approx. 11.3 hectares and consists of two Titles. Refer to Figure 1 for a current site layout plan. The legal descriptions of the two allotments are:

- Lot 2 DP 16884 – 4 Golf Links Road (0.9806ha)
- Part RS 1054 – 518 Rangiora Woodend Road (10.229ha)

Aside from the building locations and their driveways, the site was covered by short grass and used for grazing at the time of our site visits on 26 April and 3 October 2023. The topography of the site is generally flat with some undulations and two notable channel features (refer to Figure 1). The channels flowing from the west converge at around the centre point of 518 Rangiora Woodend Road. The channel features may be considered as “normally dry” though are part of the WDC mapped overland flow network⁶.

The Waimakariri Three Waters Map Viewer⁷ shows an existing council owned natural stormwater channel (Taranaki Stream) runs along the northern property boundary of 4 Golf Links Road and through the centre of the 518 Rangiora Woodend Road towards east. A tributary of Taranaki Stream runs across the site from northwest and converges to Taranaki Stream (refer to Figure 1). During our site work the channels were dry so are regarded as ephemeral watercourses.

The Cam River/Ruataniwha is located to the southwest of the site and the Ashley River is approximately 1.7km north of the site.

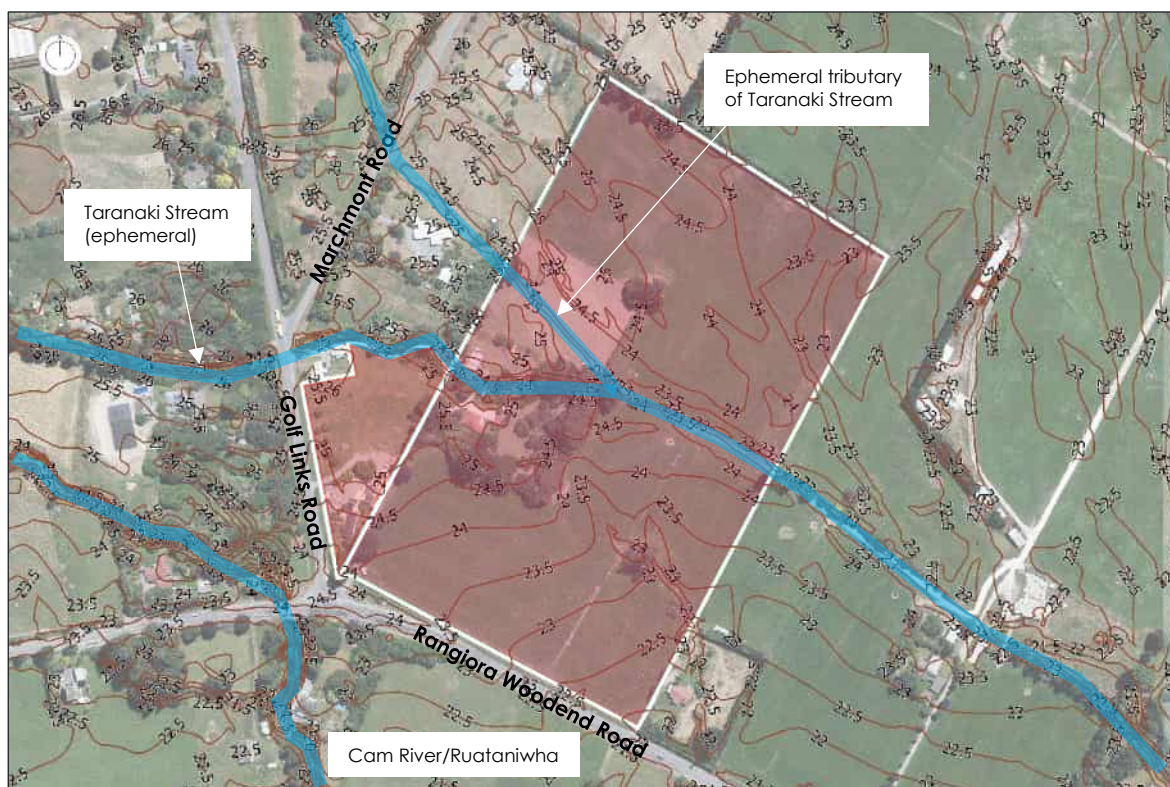


Figure 1. Site layout overlaying with contour and overland channel feature.

⁶ Refer to WDC natural hazards flood mapping: <https://letstalk.waimakariri.govt.nz/natural-hazards>

⁷ Refer to WDC Three Waters Viewer: <https://openmaps-waimakariri.hub.arcgis.com>

4. Existing Data Review

4.1. Geology

Geological mapping⁸ of the area indicates the site is underlain with “Modern river floodplain/low-level degradation terrace. Unweathered, variably sorted gravel/sand/silt/clay. Surfaces <2-degree slope (Q1a)”, comprising of river deposits.

4.2. Active Faults

The GNS database⁹ indicates the site is located outside the minimum 20m fault avoidance zone recommended by the Ministry for the Environment¹⁰.

4.3. MBIE Technical Categories

The MBIE Category has mapped the site as ‘N/A – Rural & Unmapped’.

4.4. Listed Land Use Register Records

The ECan ‘Listed Land Use Register (LLUR)’ has indicated there is potential for pesticides and herbicides to have been used (HAIL A10 Activities) on 4 Golf Links Road. No LLUR records are recorded for 518 Rangiora Woodend Road.

Refer to Eliot Sinclair’s Preliminary Site Investigation (PSI) Report, dated 13 June 2023 for more details.

4.5. Nearby Geotechnical Data

We have reviewed the NZGD portal and the ECan well cards database for nearby borehole logs. Relevant ECan well logs are as shown in Table 1. Refer to Appendix A for the borehole and well factual logs and a location plan.

BH_189061 is located at 174 East Belt to the northwest of the site. The borehole encountered sandy silty topsoil/silty sand to 0.4m bgl, overlying interbedded silty sandy gravels and thin layers of silt to 15.08m bgl. The groundwater was recorded at around 4.1m bgl in July 2019.

BH_189062 is located at 52 Kippenberger Avenue to the west of the site. The borehole encountered sandy silty topsoil/silty sand to 1.4m bgl, overlying interbedded silty sandy gravels and gravelly silt to 15.08m bgl. The groundwater was recorded at around 4.0m bgl in July 2019.

The ground conditions are markedly naturally variable across the large site area, with a notable variable being the presence and thickness of a shallow gravel body, which had implications for the choice of ground investigation method – see later in report for details.

⁸ Nathan, S., Rattenbury, M.S., Suggate, R.P. (compilers) 2002. Geology of the Greymouth area. Institute of Geological and Nuclear Sciences 1: 250 000 geological map 12. 1 sheet + 58p. Lower Hutt, New Zealand. Institute of Geological and Nuclear Sciences Limited

⁹ GNS Science - Active Faults Database

¹⁰ Planning for Development of Land on or Close to Active Faults: A Guideline to Assist Resource Management Planners in New Zealand (Published July 2003).

Table 1. Summary of nearby ECan Well and Bores data.

Bore or Well No.	Location	Total Depths (m)	Ground Water Level (m bgl)	Soil Profile
BW24/0207	22 Marchmont Road	18.00	2.20	Brown clayey/grey gravel at between 0.5m - 18m bgl with a thin layer of clay at between 9m – 10m bgl
M35/1837	6 Marchmont Road	6.00	2.56	Sandy gravel to 6m bgl
BW24/0632	6 Marchmont Road	14.87	2.02	Gravelly clay at between 0.3m – 4.0m bgl, overlying various gravels to 15m bgl
M35/0366	26 Golf Links Road	14.80	2.70	No data for upper 5.8m; Various gravels to 14.8m bgl
M35/7658	16 Golf Links Road	11.00	3.10	Sand/clay to 11m bgl
M35/0276	476 Rangiora Woodend Road	32.30	0.60	No data for upper 3.7m; sandy clay at between 3.7m – 10.7m, overlying various gravels with sand/clay to 32.3m bgl

5. Geotechnical Site Investigation

5.1. Scope

For the proposed activity of a plan change, the scope of geotechnical testing is to be in accordance with MBIE Guidance Module 2: *Geotechnical investigations for earthquake engineering*. For the site area (approx. 11.3ha) the Guidance recommends a minimum of 12 deep tests (Table 2.1) and for these to be evenly distributed across the entire site area (Table 2.2).

5.2. Cone Penetration Testing

5.2.1. Overview

McMillan Drilling Ltd undertook 15 Cone Penetrometer Tests (CPTu) starting from 31 July to 2 August 2023 to characterise the deeper soil profile. The CPTs were carried out in accordance with ASTM Standard D5778-12 'Test Method for Performing Electronic Friction Cone and Piezocone Penetration Testing of Soils'. The CPT test data was provided as a full electronic record for use in later data interpretation and analyses. Some dissipation tests were carried out in granular free-draining materials at the end of the CPT testing for groundwater level interpretation.

5.2.2. CPT Soil Behaviour Type

Refer to Appendix B for CPT records and a test location plan.

The majority of CPT tests at the northern part of 518 Rangiora Woodend Road (CPT_01, 02, 03, 03A, 04, 05, 06, 06A and 08) and 4 Golf Links Road (CPT_07 and 13) had early practical refusal on inferred dense sand or gravel to various depths extending to 1.01m – 4.86m bgl.

In the area near the southern property boundary of 518 Rangiora Woodend Road, CPT_09 indicates clay/silty clay/silty sand-like soils to around 12.3m bgl with a thin layer of clean sands to silty sands-like soil at between 2.5m – 3.0m bgl, overlying the dense sand-like soil to 12.8m bgl where testing was terminated. The dissipation test indicates the ground water level (GWL) was around 1.6m bgl.

At the location of CPT_10, the CPT data indicates interbedded silty clay/sandy silt/silty clay-like soil to 7.64m bgl with a layer of clean sand/silty sands-like soil at between 1.4m – 2.5m bgl. The dissipation test indicates the GWL is located at around 1.2m bgl.

At the location of CPT_11, the CPT data indicates interbedded clay/silty sand/silty clay-like soil to 8.7m bgl, overlying dense sand-like soil to 9.05m bgl where practical refusal has been met. The dissipation test indicates the GWL is located at around 1.2m bgl.

At the location of CPT_12, the CPT behaviour type indicates clay/silty clay to around 1.5m bgl, overlying clean sands/silty sands to 3.0m bgl, over interbedded clay/silty clay to 8.7m bgl, over clean sands/silty sands to 10.23m bgl. The dissipation test indicates the GWL is located at around 0.4m bgl.

5.3. Sonic Core Borehole Drilling Testing

Due to the shallow practical refusal for most CPTs on site, Pro-Drill Limited undertook 8 Sonic Core Boreholes (BHs) with Standard Penetration Tests (SPTs) from 3 October to 5 October 2023, as supplementary testing to characterise the deeper soil profile as investigation pairings at the shallow CPTs. Refer to Appendix C for Borehole logs and a test location plan.

The SPTs were carried out in accordance with ASTM Standard D1586-11 'Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils'. The SPT hammer efficiency was calibrated in accordance with ASTM Standard D4633-10 'Standard Test Method for Energy Measurement for Dynamic Penetrometers'.

A summary of all drilled boreholes undertaken is given in Table 2.

Table 2. Summary of machine boreholes drilled.

BH No.	Address	Location		Depth (m bgl)	Ground Water Level (m bgl)
		Easting	Northing		
BH_01	518 Rangiora Wooded Road	1569113	5206109	10.6	2.9
BH_02	518 Rangiora Wooded Road	1569203	5206052	10.6	2.3
BH_03	518 Rangiora Wooded Road	1569312	5205985	10.6	2.2
BH_04	518 Rangiora Wooded Road	1569062	5206004	10.6	3.1
BH_05	518 Rangiora Wooded Road	1569157	5205943	10.6	2.5
BH_06	518 Rangiora Wooded Road	1569266	5205883	10.6	2.2
BH_07	4 Golf Links Road	1568902	5205871	10.6	3.5
BH_08	518 Rangiora Wooded Road	1569077	5205794	10.6	2.4

Standard Penetration Tests were typically carried out at nominal 1.5m centres and the uncorrected N-values were recorded every 75mm intervals on the borehole logs. SPT hammer efficiencies used during the tests are 81.5% for all drilled boreholes.

The deep borehole tests undertaken at the centre and the northern half of 518 Rangiora Woodend Road, and 4 Golf Links Road indicate the depth to the shallow gravels below the ground surface is generally located at between 0.3m – 2.8m bgl with various thickness of 4.5m – 8.2m. Below that the ground is underlying the interbedded clayey silt/sand/silt to around 9m bgl, over the dense gravel to 10.6m bgl where testing was terminated.

Based on the results of both CPTs and borehole tests, we consider there is a transition of ground profile between the deep gravels and deep fine-grained soils towards the south property boundary of 518 Rangiora Woodend Road, due to a gradual reduction of the thickness of upper gravel layers or completely missing.

5.4. Groundwater Depth

Information on the groundwater level across the site has been obtained from three datasets, being the CPT porewater pressure (u_2) profiles, the CPT dissipation tests, and the driller's BH observations recorded on the borehole logs. The borehole observations may be the least reliable as they can be influenced by the process of drilling (with water used as the drill flush).

Based on our analysis, the u_2 pore water pressure profiles and the dissipation tests generally indicate the consistent groundwater depths. We noticed that the dissipation tests for CPT_12 indicates GWL at 0.4m bgl which is very shallow comparing to other GWL data at the site. We consider this is because the ground elevation gradually falls towards the eastern area, and the elevation difference across the whole site in west-east direction is around 2m, as indicated in the site contour map.

The land elevation broadly falls from north to south across the site with an elevation difference of approx. 3m. The groundwater depth data indicates a compatible trend with a deeper groundwater depth in the north and becoming shallower to the south. At the time of our fieldwork the data indicates groundwater depth as approx. 3m towards the north (CPTu04) and as shallow as 0.4m in the south (CPTu12).

6. Liquefaction Hazard Assessment

6.1. Assessment Methods

Using the most recent version of MBIE's residential guidelines and Supplement Issue 7, the calculation of CPT based liquefaction triggering was undertaken using the method outlined in Boulanger & Idriss (2014)¹¹. The estimation of post-liquefaction induced settlements for CPTu using the method outlined by Zhang et al (2002)¹². The liquefaction analysis was calculated using both CLiq¹³ and LiqSVs¹⁴.

The calculation of SPT based liquefaction triggering was undertaken using the method outlined in Boulanger & Idriss (2008)¹⁵.

Refer to Appendix D for CPT-based liquefaction analysis report and Appendix E for SPT-based liquefaction analysis report.

The results of deep CPTs (CPT_09 to 12) and SPTs (SPT_01 to 08) were analysed for both the Serviceability Limit State (SLS) and the Ultimate Limit State (ULS) levels of earthquake shaking as per NZGS Module 1 showing below:

- SLS1 (1:25 year return period) Case 1: M7.5, PGA 0.13g;
- SLS2 (1:25 year return period) Case 2: M6.0, PGA 0.19g; and
- ULS(1:500 year return period) M7.5, PGA 0.35g.

Based on our analysis of the CPT data we have adopted the groundwater depths interpreted from both CPT u_2 curves and the dissipation tests at each CPT test location and assumed the earthquake groundwater depths to be 0.5m higher than the static condition for the purpose of a conservative analysis.

For SPT-based liquefaction assessment we have adopted the groundwater depths measured from each drilled borehole during a static condition and assumed the earthquake groundwater depths to be 0.5 higher during a seismic loading condition for the purpose of a conservative analysis.

¹¹ Boulanger, R. W., and Idriss, I. M. (2014). *CPT and SPT based liquefaction triggering procedures*. Report No. UCD/CGM-14/01, Centre for Geotechnical Modelling, Department of Civil and Environmental Engineering, University of California, Davis, CA, 134 pp.

¹² Zhang, G., Robertson, P.K. & Brachman, R. (2002). *Estimating liquefaction-induced ground settlements from CPT for level ground*. Canadian Geotechnical Journal, 39(5): 1168-1180.

¹³ CLiq (version 2.3.1.14). GeoLogismiki Geotechnical Software

¹⁴ LiqSVs (version 2.0). GeoLogismiki Geotechnical Software

¹⁵ Boulanger, R. W., and Idriss, I. M. (2008). *Soil Liquefaction During Earthquakes*. Department of Civil and Environmental Engineering, University of California.

6.2. CPT-Based Liquefaction Assessment

6.2.1. Settlement (S_{VID})

The liquefaction-induced 'index' settlement values were calculated using method the by Zhang et al (2002)¹² for a range of parameters that are estimated from the four basic CPT parameters (depth, cone tip resistance, skin friction and pore water pressure) and represent 'free-field' settlements. Therefore, the settlements shown in Table 3 are not an exact figure, but only index values for interpretation of relative susceptibility to the damaging effect of liquefaction.

Table 3. CPT-based liquefaction-induced 'index' settlement values.

Test No.	Depth of CPT test (m bgl)	Liquefaction-induced 'index' settlements (mm)			MBIE Equivalent land classification at test location
		SLS1 (M7.5, 0.13g)	SLS2 (M6.0, 0.19g)	ULS (M7.5, 0.35g)	
CPT_09	12.80	25	35	52	TC2
CPT_10	7.64	17	28	56	TC2
CPT_11	9.05	38	57	96	TC3 / TC2
CPT_12	10.23	52	59	72	TC3 / TC2

Note: The "TC3 / TC2" descriptor relates to our assessment that the basic CPT data analysis indicates TC3 land performance (for some SLS cases – highlighted blue), but our interrogation of the analysis outputs (refer to Appendix D) finds that TC2 land performance is expected.

6.2.2. CPT-Based Liquefaction severity number (LSN)

The liquefaction severity number (LSN) is a parameter developed to reflect the more damaging effects of shallow liquefaction on residential land and shallow foundations. The estimated LSN values for the four CPT tests are summarised in Table 4.

Table 4. Maximum LSN of analysed CPTs.

Event	Maximum LSN Range	Predominant Performance
SLS	10 – 20	Minor expression of liquefaction
ULS	30 – 40	Moderate to severe exp. of liquefaction

6.3. SPT-Based Liquefaction Assessment

6.3.1. Settlement (S_{v1D})

The liquefaction-induced 'index' settlement values were calculated using the software LiqSVs¹⁶ for a range of parameters that are estimated from the basic SPT parameters and represent 'free-field' settlements. Refer to Table 5.

Table 5. SPT-based liquefaction-induced 'index' settlement values.

Test No.	Liquefaction-induced 'index' settlements (mm)			MBIE Equivalent land classification at test location
	SLS1 (M7.5, 0.13g)	SLS2 (M6.0, 0.19g)	ULS (M7.5, 0.35g)	
BH_01	3	4	78	TC2
BH_02	9	17	84	TC2
BH_03	6	9	41	TC2
BH_04	10	31	55	TC2
BH_05	2	2	35	TC2
BH_06	10	14	79	TC2
BH_07	37	65	120	TC3 / TC2
BH_08	16	53	97	TC3 / TC2

Note: The "TC3 / TC2" descriptor relates to our assessment that the basic SPT data analysis indicates TC3 land performance (for some SLS cases, and a ULS case – highlighted blue), but our interrogation of the analysis outputs (refer to Appendix E) finds that TC2 land performance is expected.

6.4. Lateral deformation hazard

The current terrain setting of the site is such that the risk of earthquake-induced lateral deformation (stretch) is relatively low.

Changes to the land during engineering design for site development shall be subject to review for potential adverse changes to lateral deformation hazard.

6.5. Site-Specific Technical Category

The broad-brush site-specific investigation and assessment of CPT and borehole records presented above determines that **equivalent TC2 land performance** is generally predicted for the site for the purposes of the Plan Change application.

The MBIE residential development guidance document (Table 3.1) provides the following index criteria for the technical categories:

¹⁶ LiqSVs (version 2.0). GeoLogismiki Geotechnical Software

Table 3.1: Index criteria for foundation technical categories

Foundation Technical Category	Future land performance expectation from liquefaction	Nominal SLS land settlement	Nominal ULS land settlement	Nominal Lateral Stretch
TC1 (where confirmed)	Liquefaction damage is unlikely in a future large earthquake	0–15 mm	0–25 mm	Generally not expected
TC2 (where confirmed)	Liquefaction damage is possible in a future large earthquake	0–50 mm	0–100 mm	<50 mm
TC3 (where confirmed)	Liquefaction damage is possible in a future large earthquake	>50 mm	>100 mm	>50 mm

The MBIE guidance (Section 1.4.3) states: “TC2: Liquefaction damage is possible in future large earthquakes. Standard enhanced foundation repair and rebuild options in accordance with MBIE guidance are suitable to mitigate against this possibility.”

7. Natural Hazard Risk Assessment

7.1. Introduction

Council can decline an application for subdivision consent if there is a significant risk from natural hazards. To determine whether there is a significant risk from natural hazards, decision-makers are guided by the requirements of RMA Section 106(1A)¹⁷. This requires a combined assessment of:

- The **likelihood** of natural hazards occurring (whether individual or in combination); and
- The **consequences** (material damage) that would result from natural hazards to land where the consent is sought, other land, or structures; and
- Any **likely subsequent use** of the land where the consent is sought that would **accelerate, worsen, or result in material damage**.

Decision-makers are required to consider the magnitude of risk of natural hazards, including natural hazards that have a high impact but low probability of occurrence. This aligns the assessment with the definition of 'effect' Section 3 of the RMA.

The RMA defines natural hazards as: *Any atmospheric or earth or water related occurrence (including earthquake, tsunami, erosion, volcanic and geothermal activity, landslip, subsidence, sedimentation, wind, drought, fire, or flooding) the action of which adversely affects or may adversely affect human life, property, or other aspects of the environment.*

Hazard identification is a key component of any site-specific risk assessment. The risk assessment for relevant natural hazards at the site is presented below, which considers the likelihood and consequences of the hazard at the site in the context of the proposed activity (plan change from rural to residential land use) as compared against the current site context.

We have considered the risk of falling debris, subsidence, wind, drought, fire, geothermal activity, sedimentation, climate change, sea level rise, and volcanic activity and conclude these are very unlikely to pose an unacceptable risk to life at this site.

In relation to other potential natural hazards, we comment as follows:

7.2. Earthquake Shaking

New Zealand is a seismically active country. New buildings and infrastructure will be designed, consented, and built to acceptable industry standards and New Zealand Building Code requirements. As such the earthquake shaking risk to buildings will be managed to acceptable levels.

¹⁷ For the purposes of this Plan Change assessment we have adopted the s106 natural hazard assessment framework normally applied to subdivision applications. This is to give a familiar format of assessing natural hazards for land development, generally. An application for subdivision is a likely next step following the District Plan review process if this rezoning submission is successful.

7.3. Flooding

The Waimakariri Flood Hazard Map indicates the flood hazard within the Taranaki Stream (and tributaries) is Low to Medium from the 200 Year ARI rainfall event as shown in Figure 2.

Refer to Eliot Sinclair's Flood Impact Assessment Report¹⁸ for flood modelling details of the site.

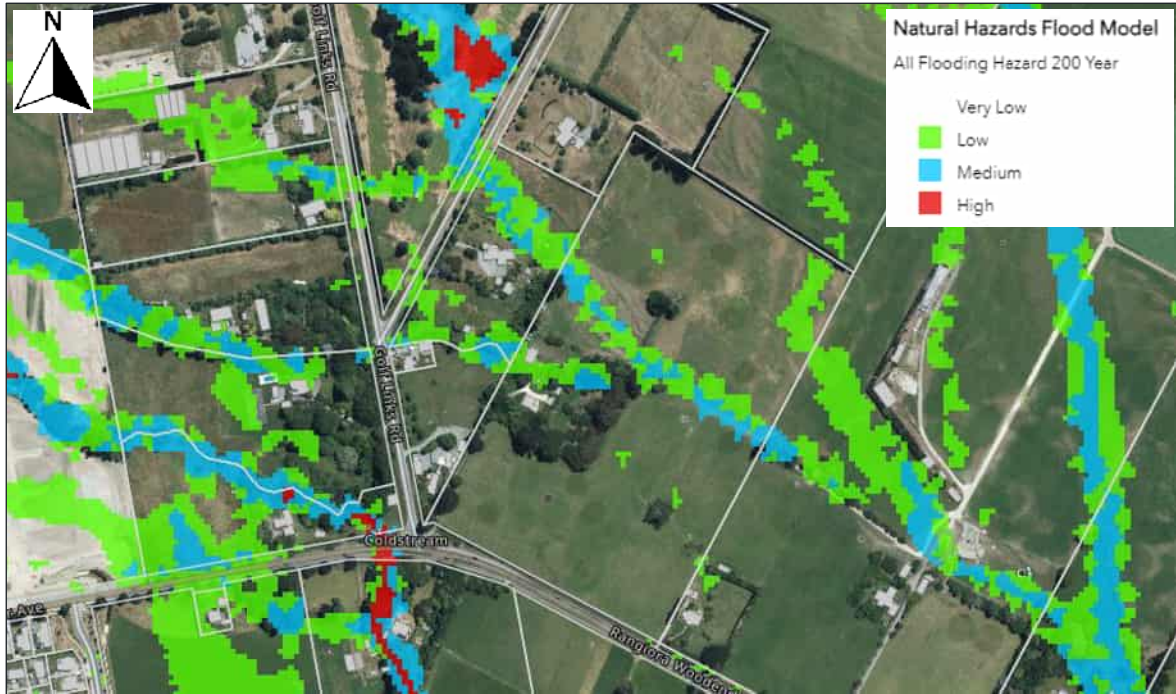


Figure 2. Current level of flood hazard at the site (Waimakariri Flood Hazard Map, October 2023).

¹⁸ Flood Impact Assessment – 4 Golf Links Road and 518 Rangiora Woodend Road, Rangiora, Version A, Ref: 511185, prepared by Eliot Sinclair, dated 10 October 2023.

7.4. Liquefaction Vulnerability Mapping

The WDC liquefaction vulnerability mapping¹⁹ indicates a liquefaction boundary line going across the site which identified the eastern two-thirds of the site as “Liquefaction damage is possible”, and the western third of the site as “Liquefaction damage is unlikely”. Refer to Figure 3.

However, we consider this is a regional scale map with the boundary between the two areas being relatively arbitrary at the site-specific scale.

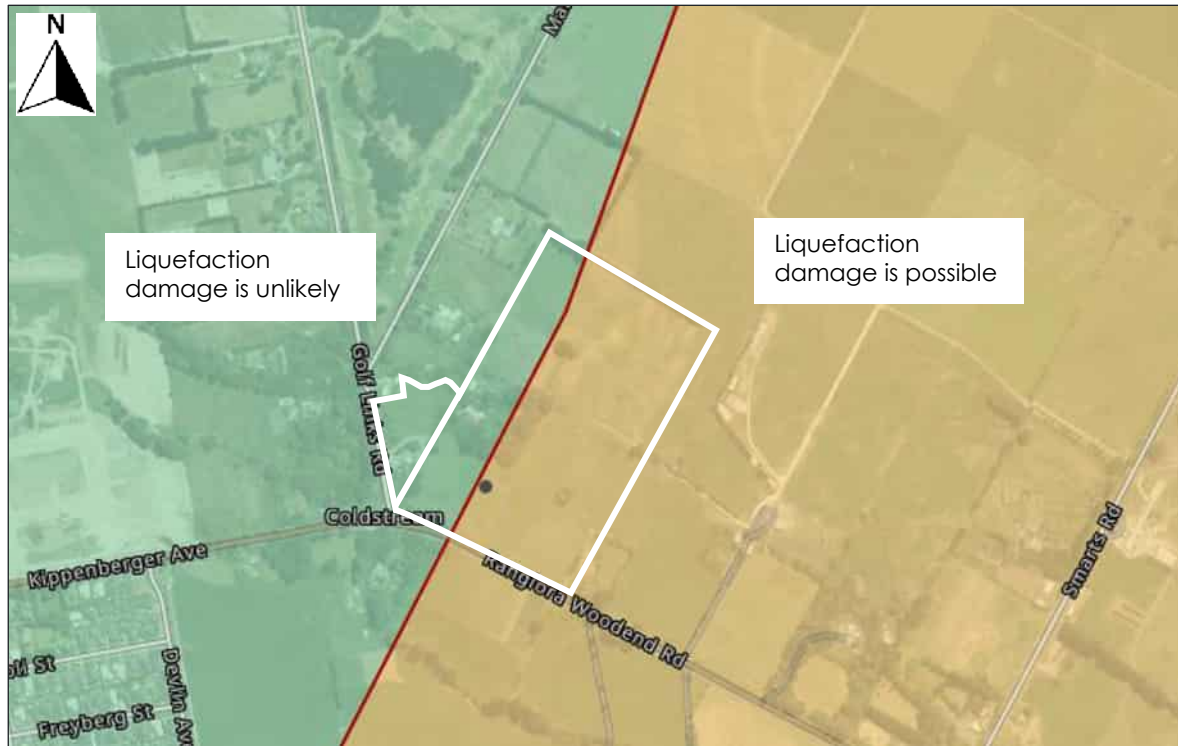


Figure 3. Liquefaction vulnerability map (WDC Natural Hazards map, October 2023).

Our broad-brush site-specific investigation and assessment of CPT and borehole records presented above determines that **equivalent TC2 land performance** is generally predicted for the site for the purposes of the rezoning submission request.

¹⁹ WDC natural hazards mapping: <https://letstalk.waimakariri.govt.nz/natural-hazards>

7.5. Erosion and Subsidence

The site is gently undulating. At the time of our site walkover inspection, we did not find any obvious evidence of significant erosion or subsidence. We have reviewed the aerial photographs for the channel features and consider that it is unlikely for proposed buildings being affected by erosion as the building will be set outside of channels. Appropriate design of infrastructure and buildings will manage the risk of erosion to acceptable levels.

There are no identified special / unusual ground conditions that would raise concern for a Plan Change rezoning request regarding subsidence. Subsidence risk will be managed to acceptable levels via normal investigation and engineering design practices for infrastructure and buildings.

An Erosion and Sediment Control Plan should be in place for any earthworks or construction at the site, in accordance with normal earthworks management practices.

8. Conclusions

Based on our geotechnical investigation, we consider the site at 518 Rangiora Woodend Road and 4 Golf Links Road is suitable for rezoning from rural to residential land use.

We consider the site can be rezoned and that natural hazards can be mitigated through good development design and practice to ensure the safety of infrastructure, buildings and people.

9. Proposed District Plan Rules

No rules to manage geotechnical risk are proposed.

There are no special conditions of the site identified that warrant geotechnical risk management measures beyond those that fall within normal infrastructure and building investigation and design practices.

10. Disclaimer

This report has been prepared by Eliot Sinclair & Partners Limited ("Eliot Sinclair") only for the intended purpose as a Natural Hazards Risk Assessment for a Plan Change application. Our analysis is based on our inspection of the site and geotechnical testing.

The report is based on:

- Information shown on NZS3604:2011, WestMaps, Beca Regional Liquefaction Report, and GNS's Active Faults Database.
- Ministry of Business, Innovation and Employment's (MBIE) December 2012 guidelines.
- Factual borehole and CPT records.

Where data supplied by CVI Projects Ltd or other external sources have been relied upon, it has been assumed that the information is correct unless otherwise stated. No responsibility is accepted by Eliot Sinclair for incomplete or inaccurate data supplied by other parties.

Whilst every care has been taken during our investigation and interpretation of the subsurface conditions to ensure that the conclusions drawn, and the opinions and recommendations expressed are correct at the time of reporting, Eliot Sinclair has not performed an assessment of all possible conditions or circumstances that may exist at the site. Variations in conditions may occur between investigatory locations and there may be conditions such as subsoil strata and features that were not detected by the scope of the investigation that was carried out or have been covered over or obscured over time. Additionally, on-going seismicity in the general area may lead to deterioration of ground conditions that could not have been anticipated at the time of writing this report. Eliot Sinclair does not provide any warranty, either express or implied, that all conditions will conform exactly to the assessments contained in this report.

The exposure of conditions that vary from those described in this report, or occurrence of additional strong seismicity, or any future update of MBIE's guidelines may require a review of our recommendations. Eliot Sinclair should be contacted to confirm the validity of this report should any of these occur.

This report has been prepared for the benefit of CVI Projects Ltd and the regulatory authority for the purposes as stated above. This report is specifically prepared for the proposed Plan Change application and should not be used to support any future consent application without prior review and approval by Eliot Sinclair. No liability is accepted by Eliot Sinclair or any of their employees with respect to the use of this report, in whole or in part, for any other purpose or by any other party.

Appendix A. Nearby Borehole and Well Records



BOREHOLE RECORD

HOLE NO. **BH1**
PROJECT NO. **506685**

PROJECT **Westpark - Inch Land Geotechnical Investigation Rangiora**

METHOD **SNC**

CO-ORDINATES (NZTM)

SHEET **1** of **2**

MACHINE & NO. **Geoprobe 8140LS - Track**

E 1568297
N 5206283

DATE from **01/07/2019** to **02/07/2019**

FLUSHING MEDIUM **Water**

ORIENTATION **VERTICAL**

GROUND-LEVEL **+28.00** m RL

Drilling Progress	Water level (m) shift start/end	Water Recovery %	Total core Recovery %	Solid core Recovery %	R.Q.D.	Fracture Index	Tests	Samples	Reduced Level	Depth (m)	Legend	STRATA DESCRIPTION		Instrument/ Backfill
												SUBORDINATE FRACTION, MAJOR FRACTION, MINOR FRACTION, COLOUR, STRUCTURE, STRENGTH, MOISTURE CONDITION, GRADING, BEDDING, PLASTICITY, ETC.... (NZ GEOTECHNICAL SOCIETY - FIELD DESCRIPTION OF SOIL AND ROCK)		
			100						0.00	0.00				
							(15, 14, 13, 13, 9, 10) N = 45/450 mm		+27.85	0.15		Sandy SILT with trace rootlets; dark brown. <i>Firm</i> , moist, non-plastic; sand, fine. (TOPSOIL)		
							(22, 20, 18, 15, 16, 11) N = 60/445 mm		+27.60	0.40		Silty SAND with trace rootlets and gravel; brown. <i>Dense</i> , moist; gravel, fine to coarse, rounded to sub rounded; sand, medium.		
							(8, 7, 7, 7, 7, 11) N = 32/450 mm		+23.60	4.40		Sandy GRAVEL with minor silt and trace cobbles; yellowish brown. <i>Dense</i> , moist; gravel, fine to coarse, rounded to sub-rounded; sand, medium to coarse.		
			60				(16, 30, 25, 22, 13) N = 60/350 mm					1.60m Becomes dry.		
			55				(11, 11, 8, 7, 6, 10) N = 31/450 mm					Sandy GRAVEL with some silt and trace cobbles; yellowish brown. <i>Dense to very dense</i> , moist; gravel, fine to coarse, rounded to sub-rounded; sand, medium to coarse.		
			100				(13, 33, 40, 20) N = 60/265 mm							

- Small Disturbed Sample
- ▨ Large Disturbed Sample
- ▨ SPT Liner Sample
- ▨ Thin Wall Undisturbed Sample
- ▨ U100 Undisturbed Sample
- ▨ Pocket Penetrometer Test
- ▨ Piston Sample
- ▼ Water Level
- ▨ Impression Packer Test
- ▨ Standard Penetration Test
- ▨ Permeability Test
- ▨ Piezometer / Standpipe Tip
- ▨ Packer Test
- ▨ In-situ Vane Shear Test

LOGGED **F. MONTEITH**
DATE **05/07/2019**
CHECKED **S. MCRAE**
DATE **23/07/2019**

REMARKS
Coordinates from handheld GPS, accurate to +/- 5m. Elevations from LINZ Data Service 1m LIDAR, accurate to +/- 1m.
Static water levels:
4.50m bgl at casing depth of 15.08; 2/07/2019, 1:30pm. 4.10m bgl in piezometer standpipe; 4/07/2019, 2.00pm

Report ID: AGS4 BOREHOLE RECORD WITH INSTALLATION || Project: WESTPARK - INCH LAND.GPJ || Library: AGS 4_0.GLB || Date: 30 July 2019



BOREHOLE RECORD


HOLE NO. **BH1**
PROJECT NO. **506685**









PROJECT	Westpark - Inch Land Geotechnical Investigation Rangiora		
METHOD	SNC	CO-ORDINATES (NZTM)	SHEET 2 of 2
MACHINE & NO.	Geoprobe 8140LS - Track	E 1568297 N 5206283	DATE from 01/07/2019 to 02/07/2019
FLUSHING MEDIUM	Water	ORIENTATION VERTICAL	GROUND-LEVEL +28.00 m RL















Drilling Progress	Water level (m) shift start/end	Water Recovery %	Total core Recovery %	Solid core Recovery %	R.Q.D.	Fracture Index	Tests	Samples	Reduced Level	Depth (m)	Legend	STRATA DESCRIPTION		Instrument/ Backfill
												SUBORDINATE FRACTION, MAJOR FRACTION, MINOR FRACTION, COLOUR, STRUCTURE, STRENGTH, MOISTURE CONDITION, GRADING, BEDDING, PLASTICITY, ETC.... (NZ GEOTECHNICAL SOCIETY - FIELD DESCRIPTION OF SOIL AND ROCK)		
			100				(15, 23, 21, 19, 18, 2) N = 60/385 mm							
							(21, 26, 23, 27, 10) N = 60/330 mm		+15.60	12.40			SILT with minor sand and gravel; brownish grey. <i>Very dense</i> , moist, low plasticity; gravel, medium, sub-rounded to sub-angular; sand, fine to coarse.	
							(18, 17, 18, 15, 12, 11) N = 56/450 mm		+15.10	12.90			Silty sandy GRAVEL; light brownish grey. <i>Very dense</i> , moist; gravel, fine to coarse, sub-rounded to sub-angular; sand, fine to coarse; silt, low plasticity.	
							(14, 20, 22, 26, 13) N = 60/330 mm		+13.50	14.50			SILT with minor sand; light brown. <i>Very dense</i> , dry, low plasticity; sand, fine.	
									+12.92	15.08			End of Sonic core drilling at 15.08m, on 02/07/2019 <i>Termination Reason:</i> Target depth reached.	

Report ID: AGS4 BOREHOLE RECORD WITH INSTALLATION || Project: WESTPARK - INCH LAND.GPJ || Library: AGS 4_0.GLB || Date: 30 July 2019


<ul style="list-style-type: none"> • Small Disturbed Sample • Large Disturbed Sample • SPT Liner Sample • Thin Wall Undisturbed Sample • U100 Undisturbed Sample • Pocket Penetrometer Test • Piston Sample 	<ul style="list-style-type: none"> ▼ Water Level ▼ Impression Packer Test ▼ Standard Penetration Test ▼ Permeability Test ▼ Piezometer / Standpipe Tip ▼ Packer Test ▼ In-situ Vane Shear Test 	LOGGED F. MONTEITH DATE 05/07/2019 CHECKED S. MCRAE DATE 23/07/2019	REMARKS Coordinates from handheld GPS, accurate to +/- 5m. Elevations from LINZ Data Service 1m LIDAR, accurate to +/- 1m. Static water levels: 4.50m bgl at casing depth of 15.08; 2/07/2019, 1:30pm. 4.10m bgl in piezometer standpipe; 4/07/2019, 2.00pm
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 www.aurecongroup.com	<h1 style="margin: 0;">BOREHOLE RECORD</h1>		HOLE NO. BH2
			PROJECT NO. 506685
PROJECT Westpark - Inch Land Geotechnical Investigation Rangiora			
METHOD SNC	CO-ORDINATES (NZTM)		SHEET 1 of 2
MACHINE & NO. Geoprobe 8140LS - Track	E 1568436 N 5205930		DATE from 02/07/2019 to 03/07/2019
FLUSHING MEDIUM Water	ORIENTATION VERTICAL		GROUND-LEVEL +26.90 m RL

Drilling Progress	Water level (m) shift start/end	Water Recovery %	Total core Recovery %	Solid core Recovery %	R.Q.D.	Fracture Index	Tests	Samples	Reduced Level	Depth (m)	Legend	STRATA DESCRIPTION		Instrument/ Backfill	
												SUBORDINATE FRACTION, MAJOR FRACTION, MINOR FRACTION, COLOUR, STRUCTURE, STRENGTH, MOISTURE CONDITION, GRADING, BEDDING, PLASTICITY, ETC..... (NZ GEOTECHNICAL SOCIETY - FIELD DESCRIPTION OF SOIL AND ROCK)			
			100					Type Ref Depth	0.00	0.00					
							(4, 4, 1, 2, 4, 6) N = 13/450 mm		+26.40	0.50		Sandy SILT with trace rootlets; dark brown. <i>Firm</i> , moist, non-plastic; sand, fine. (TOPSOIL)			
			85						+25.50	1.40		Silty SAND; yellowish brown. <i>Medium dense</i> , moist. Sand, fine; silt, non-plastic.			
			60				(8, 7, 4, 3, 3, 5) N = 15/450 mm		+23.40	3.50		Silty sandy GRAVEL with minor cobble; yellowish brown. <i>Medium dense</i> , moist; gravel, fine to coarse, rounded to sub-rounded; sand, fine to coarse; silt, non-plastic.			
			40				(6, 4, 4, 3, 2, 3) N = 12/450 mm		+22.46	4.44		Silty sandy GRAVEL; yellowish brown. <i>Medium dense</i> , moist; gravel, fine to medium, rounded to sub-rounded; sand, fine to coarse; silt, non-plastic.			
			60				(8, 7, 9, 7, 7, 7) N = 30/450 mm		+20.50	6.40		GRAVEL with minor cobble; yellowish brown. <i>Medium dense</i> , moist; gravel, fine to coarse, rounded to sub-rounded. (Drilled with water, fines lost)			
			40				(6, 10, 10, 8, 7, 8) N = 33/450 mm		+19.40	7.50		Silty sandy GRAVEL with minor cobble; yellowish brown. <i>Medium dense to dense</i> , moist; gravel, fine to coarse, rounded to sub-rounded; sand, fine to coarse; silt, non-plastic.			
			100				(12, 19, 19, 19, 20, 2) N = 60/385 mm		+17.90	9.00		GRAVEL with minor cobble; yellowish brown. <i>Dense</i> , moist; gravel, fine to coarse, rounded to sub-rounded. (Drilled with water, fines lost)			
												Silty sandy GRAVEL with minor cobble; yellowish brown. <i>Dense</i> , moist; gravel, fine to coarse, rounded to sub-rounded; sand, fine to coarse; silt, non-plastic.			

<ul style="list-style-type: none">  Small Disturbed Sample  Large Disturbed Sample  SPT Liner Sample  Thin Wall Undisturbed Sample  U100 Undisturbed Sample  Pocket Penetrometer Test  Piston Sample 	<ul style="list-style-type: none">  Water Level  Impression Packer Test  Standard Penetration Test  Permeability Test  Piezometer / Standpipe Tip  Packer Test  In-situ Vane Shear Test 	LOGGED F. MONTEITH DATE 05/07/2019 CHECKED S. MCRAE DATE 23/07/2019	REMARKS Coordinates from handheld GPS, accurate to +/- 5m. Elevations from LINZ Data Service 1m LIDAR, accurate to +/- 1m. Static water levels: 4.00m bgl at casing depth of 15.08; 3/07/2019, 8:50pm
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Report ID: AGS4 BOREHOLE RECORD WITH INSTALLATION || Project: WESTPARK - INCH LAND.GPJ || Library: AGS 4_0.GLB || Date: 30 July 2019

 www.aurecongroup.com	<h1 style="margin: 0;">BOREHOLE RECORD</h1>		HOLE NO. BH2
			PROJECT NO. 506685
PROJECT Westpark - Inch Land Geotechnical Investigation Rangiora			
METHOD SNC	CO-ORDINATES (NZTM)		SHEET 2 of 2
MACHINE & NO. Geoprobe 8140LS - Track	E 1568436 N 5205930		DATE from 02/07/2019 to 03/07/2019
FLUSHING MEDIUM Water	ORIENTATION VERTICAL		GROUND-LEVEL +26.90 m RL

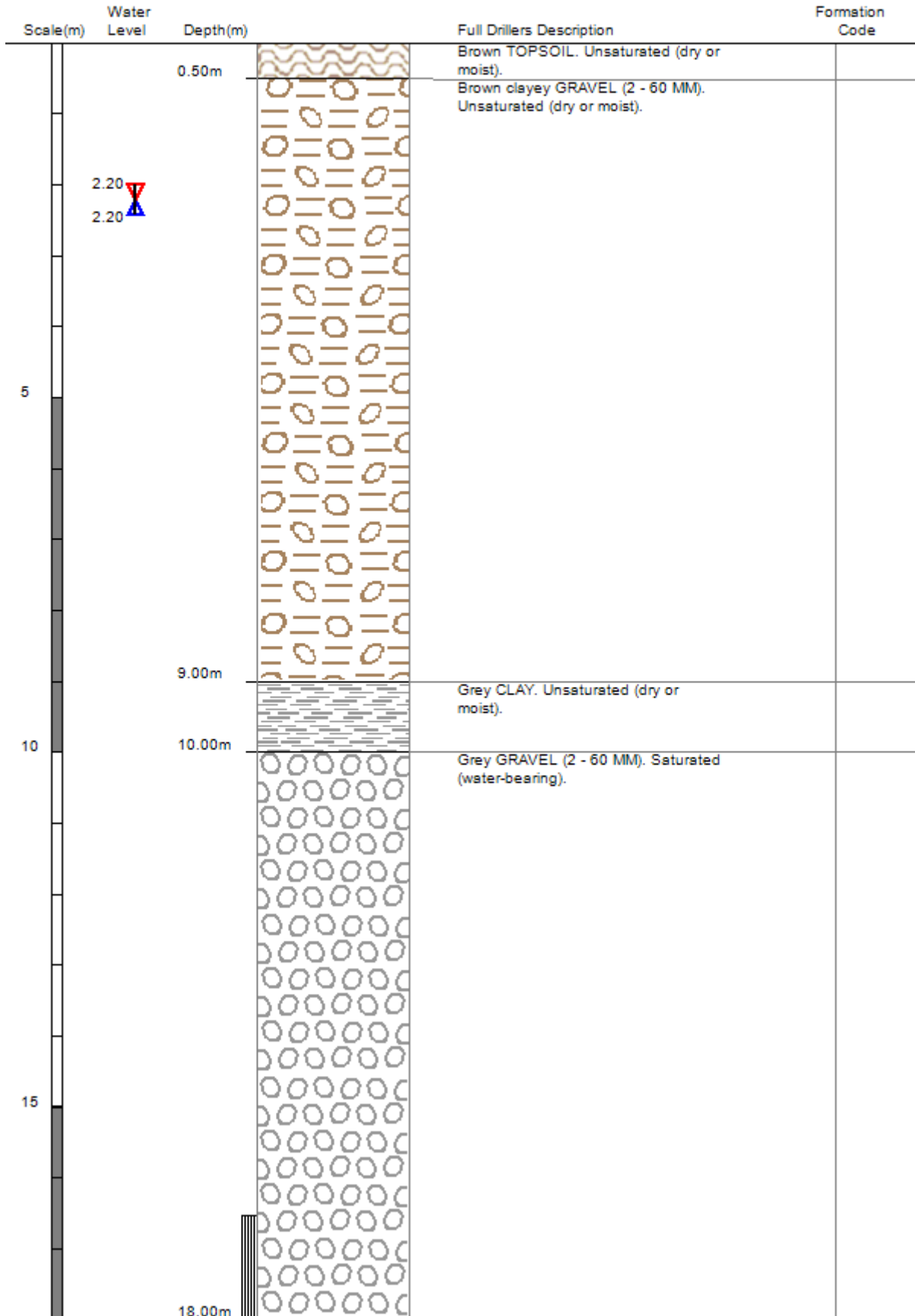
Drilling Progress	Water level (m) shift start/end	Water Recovery %	Total core Recovery %	Solid core Recovery %	R.Q.D.	Fracture Index	Tests	Samples	Reduced Level	Depth (m)	Legend	STRATA DESCRIPTION		Instrument/ Backfill
												SUBORDINATE FRACTION, MAJOR FRACTION, MINOR FRACTION, COLOUR, STRUCTURE, STRENGTH, MOISTURE CONDITION, GRADING, BEDDING, PLASTICITY, ETC.... <small>(NZ GEOTECHNICAL SOCIETY - FIELD DESCRIPTION OF SOIL AND ROCK)</small>		
			100				(9, 13, 12, 12, 13, 15) N = 52/450 mm					 12.00m Becomes wet.		
			90				(13, 24, 19, 18, 14, 9) N = 60/387 mm							
			100				(19, 30, 28, 20, 12) N = 60/360 mm		+12.40	14.50			Gravelly SILT with minor sand; yellowish brown with some orange mottling. <i>Very stiff to hard</i> , moist, non-plastic; gravel, fine to medium, sub-rounded; sand, fine.	
							(7, 19, 22, 22, 16) N = 60/360 mm		+11.82	15.08		End of Sonic core drilling at 15.08m, on 03/07/2019 <i>Termination Reason:</i> Target depth reached.		

<ul style="list-style-type: none"> • Small Disturbed Sample ▬ Large Disturbed Sample ▬ SPT Liner Sample ▬ Thin Wall Undisturbed Sample ▬ U100 Undisturbed Sample ▬ Pocket Penetrometer Test ▬ Piston Sample 	<ul style="list-style-type: none"> ▼ Water Level ▬ Impression Packer Test ▬ Standard Penetration Test ▬ Permeability Test ▬ Piezometer / Standpipe Tip ▬ Packer Test ▬ In-situ Vane Shear Test 	LOGGED F. MONTEITH DATE 05/07/2019 CHECKED S. MCRAE DATE 23/07/2019	REMARKS Coordinates from handheld GPS, accurate to +/- 5m. Elevations from LINZ Data Service 1m LIDAR, accurate to +/- 1m. Static water levels: 4.00m bgl at casing depth of 15.08; 3/07/2019, 8:50pm
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Report ID: AGS4 BOREHOLE RECORD WITH INSTALLATION || Project: WESTPARK - INCH LAND.GPJ || Library: AGS 4_0.GLB || Date: 30 July 2019

Borelog for well BW24/0207

Grid Reference (NZTM): 1569103 mE, 5206099 mN
 Location Accuracy: 10 - 50m
 Ground Level Altitude: 25.2 m +MSD Accuracy: < 2.5 m
 Driller: East Coast Drilling
 Drill Method: Air Rotary
 Borelog Depth: 18.0 m Drill Date: 15-Jul-2014



Borelog for well M35/1837

Grid Reference (NZTM): 1569000 mE, 5206049 mN

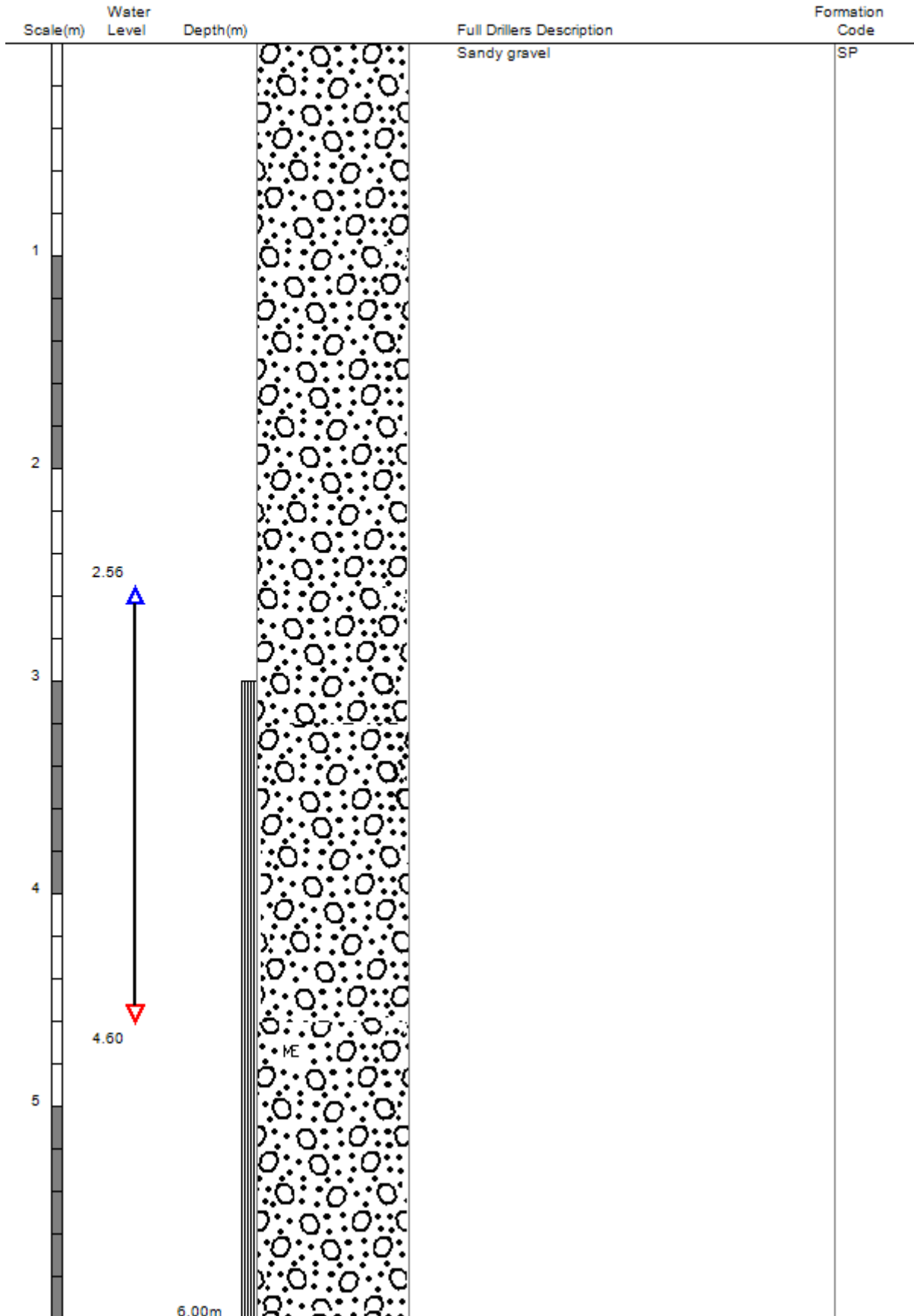
Location Accuracy: 50 - 300m

Ground Level Altitude: 25.2 m +MSD Accuracy: < 2.5 m

Driller: Not Known

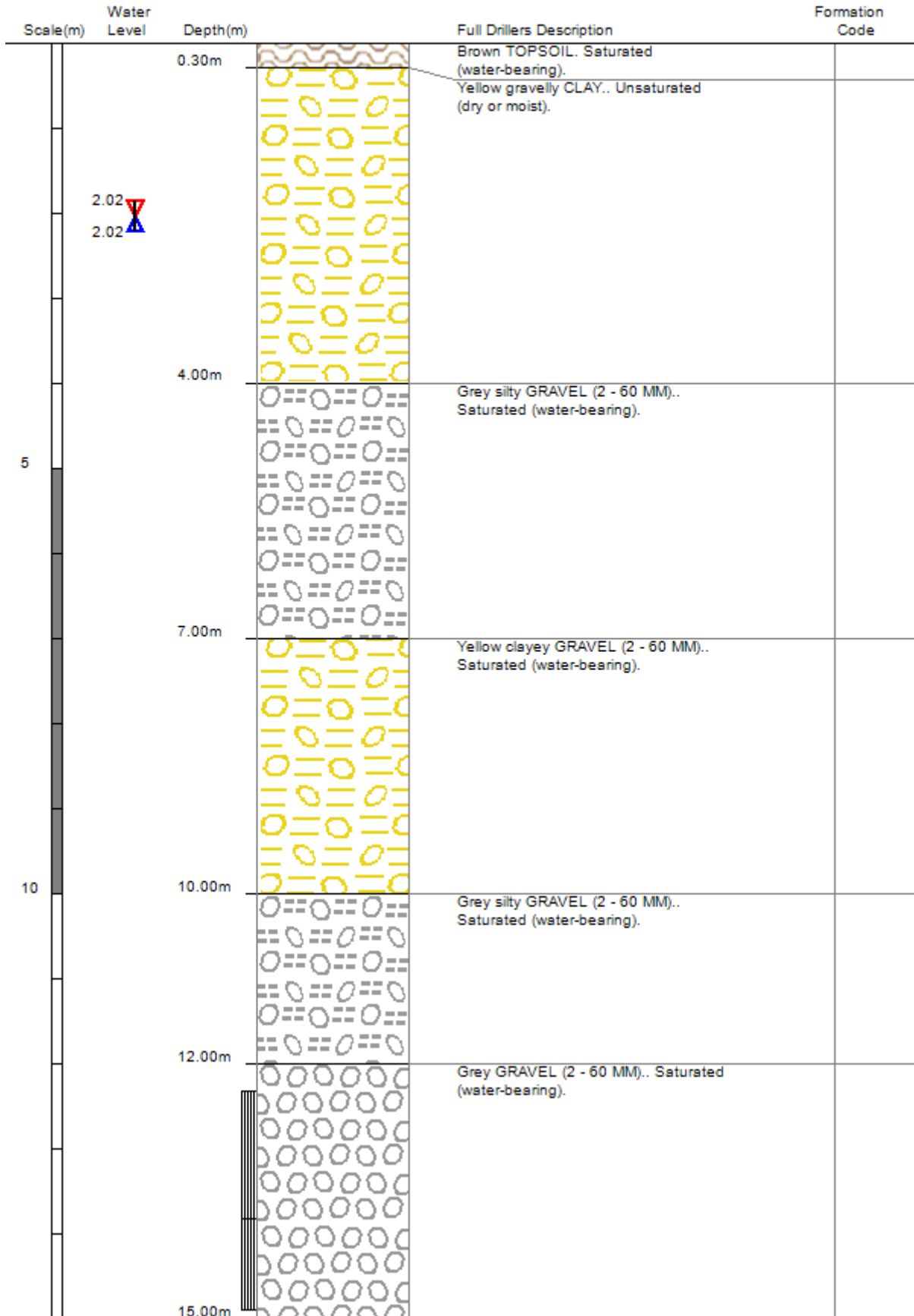
Drill Method: Unknown

Borelog Depth: 6.0 m Drill Date: 01-Feb-1982



Borelog for well BW24/0632

Grid Reference (NZTM): 1569031 mE, 5206011 mN
 Location Accuracy: 50 - 300m
 Ground Level Altitude: 25.2 m +MSD Accuracy: < 2.5 m
 Driller: Hydrill
 Drill Method: Dual Rotary
 Borelog Depth: 15.0 m Drill Date: 05-Aug-2021



Borelog for well M35/0366

Grid Reference (NZTM): 1568873 mE, 5205963 mN

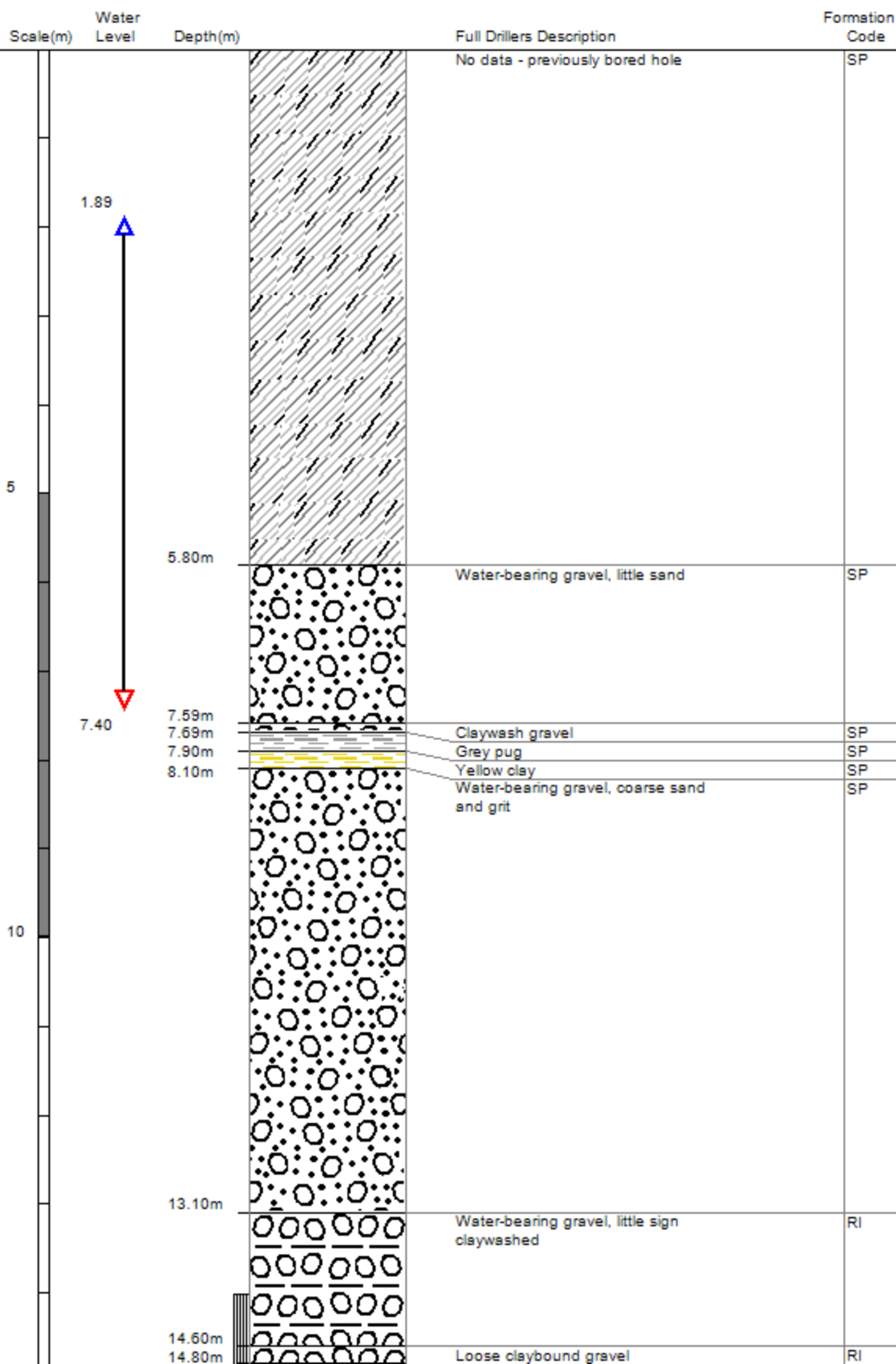
Location Accuracy: 1 - 2m

Ground Level Altitude: 26.1 m +MSD Accuracy: < 0.1 m

Driller: Clemence Drilling Contractors

Drill Method: Cable Tool

Borelog Depth: 14.8 m Drill Date: 08-Apr-1999



Borelog for well M35/7658

Grid Reference (NZTM): 1568905 mE, 5205894 mN

Location Accuracy: 2 - 15m

Ground Level Altitude: 25.8 m +MSD Accuracy: < 0.5 m

Driller: George Wheeler Welldrilling

Drill Method: Rotary/Percussion

Borelog Depth: 11.0 m Drill Date: 19-Mar-1997



Scale(m)	Water Level	Depth(m)	Full Drillers Description	Formation Code
		0.34m	Topsoil	SP
		1.40m	Yellow sand	SP
		2.80m	Yellow clay, fine gravel	SP
		2.80m	Pea metal sand	SP
5				
		9.50m	Yellow clay sand fine shingle	SP
10		10.50m	Grey medium shingle pea metal	SP
		11.00m		

Borelog for well M35/0276

Grid Reference (NZTM): 1569300 mE, 5205779 mN
 Location Accuracy: 50 - 300m
 Ground Level Altitude: 23.6 m +MSD Accuracy: < 2.5 m
 Driller: McMillan Drilling Ltd
 Drill Method: Unknown
 Borelog Depth: 32.3 m Drill Date: 01-Mar-1972



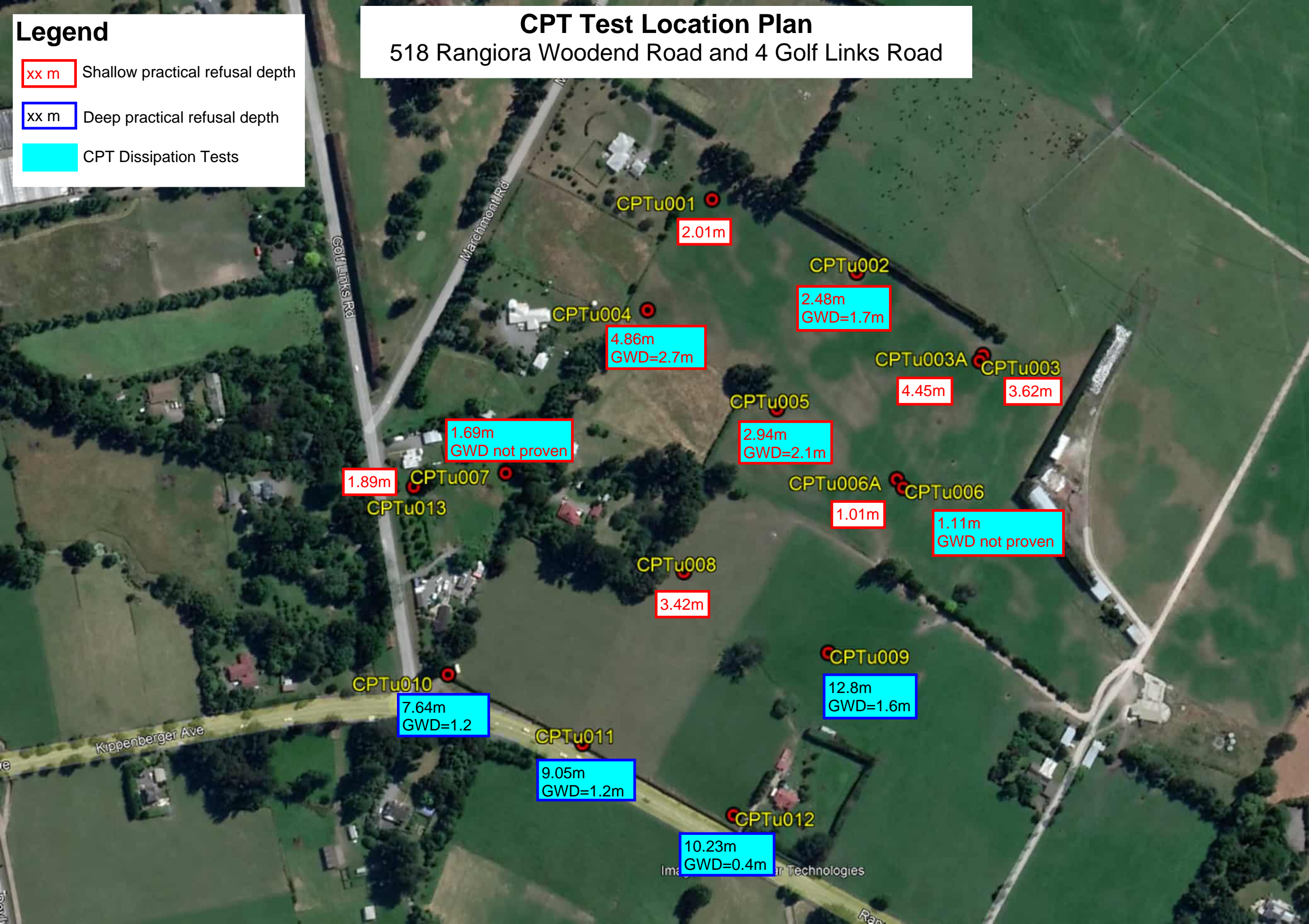
Scale(m)	Water Level	Depth(m)	Full Drillers Description	Formation Code
		3.70m	No Log No Log	Existing hole SP
5			Sandy clay	SP
10		10.70m		
		12.20m		
15		17.40m		
20		22.60m		
		23.20m		
25		25.60m		
		26.79m		
30		32.29m		

Appendix B. McMillan CPT Testing Records

Legend

- xx m Shallow practical refusal depth
- xx m Deep practical refusal depth
- CPT Dissipation Tests

CPT Test Location Plan
 518 Rangiora Woodend Road and 4 Golf Links Road



CONE PENETRATION TEST (CPT) REPORT

McMILLAN Drilling

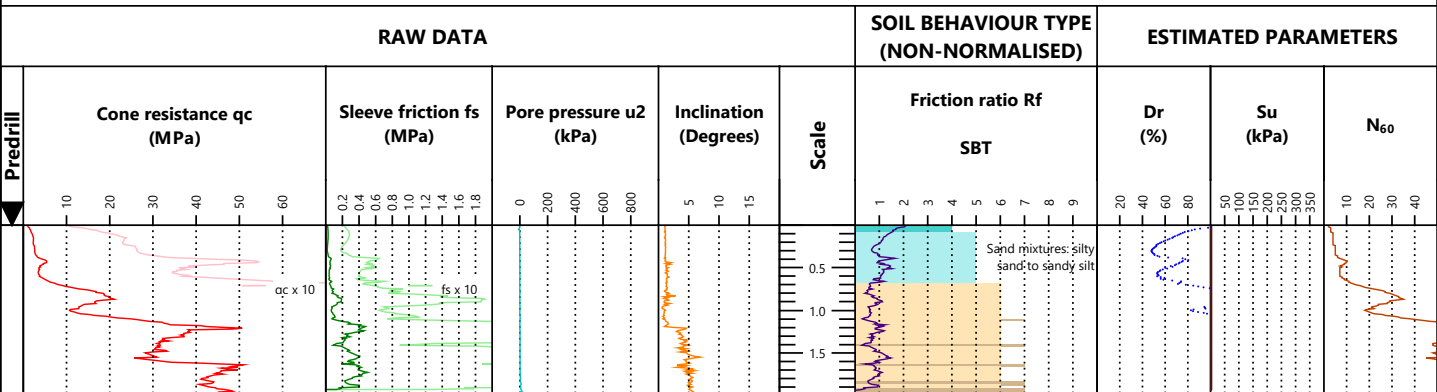
Client: Eliot Sinclair & Partners Ltd

**Location: 518 Rangiora Woodend Road,
Rangiora**

Printed: 04/08/2023

Client:	Eliot Sinclair & Partners Ltd	Bore No.:	CPTu001
Project:	518 Rangiora Woodend Road, Rangiora	Job No.:	21758

Site Location: 518 Rangiora Woodend Road, Rangiora	Date: 1/8/2023
Grid Reference: 1569114.42m E, 5206084.53m N (NZTM) - Handheld GPS	Rig Operator: E. Diaz Farias
Elevation: 0.00m	Datum: Ground
	Equipment: Geomil Panther 100



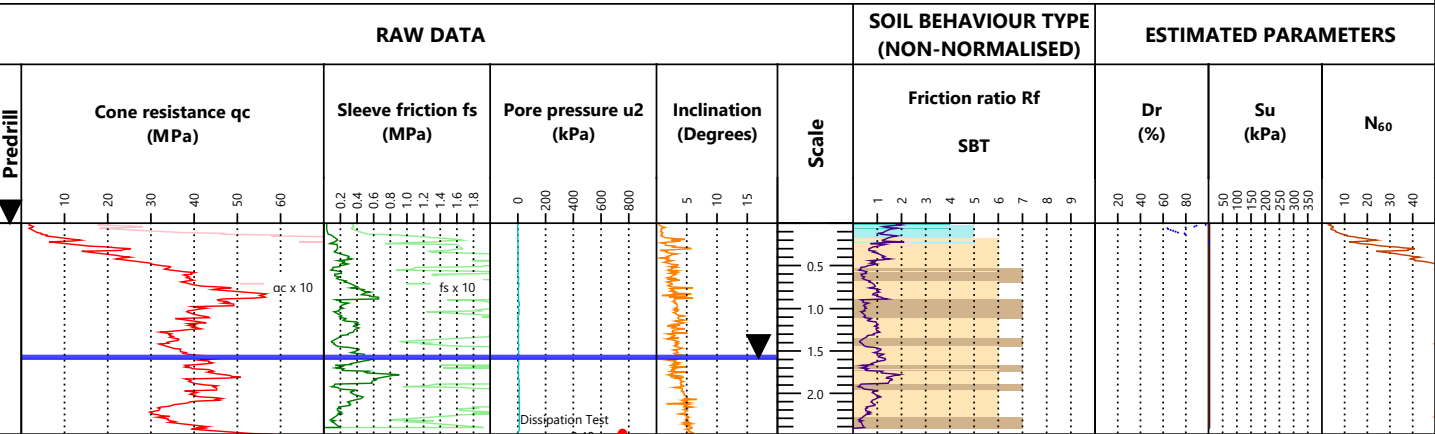
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Cone Type: Pagani Piezocone - Compression Cone Reference: MKS364 Cone Area Ratio: 0.79 Standards: ISO 22476-1:2012 - Application Class 2			Predrill: - Water Level: - Collapse: 1.70m		Termination Target Depth <input type="checkbox"/> Effective Refusal Tip <input checked="" type="checkbox"/> Gauge <input type="checkbox"/> Inclinometer <input type="checkbox"/> Other <input type="checkbox"/>		Soil Behaviour Type (SBT) - Robertson et al. 1986 0 Undefined 1 Sensitive fine-grained 2 Clay - organic soil 3 Clays: clay to silty clay 4 Silt mixtures: clayey silt & silty clay 5 Sand mixtures: silty sand to sandy silt 6 Sands: clean sands to silty sands 7 Dense sand to gravelly sand 8 Stiff sand to clayey sand 9 Stiff fine-grained		
Zero load outputs (MPa) Tip Resistance Local Friction Pore Pressure	Before test 24.3466 0.2561 2.9479	After test 24.3518 0.2563 2.9484							

Notes & Limitations Data shown on this report has been assessed to provide a basic interpretation in terms of Soil Behaviour Type (SBT) and various geotechnical soil and design parameters using methods published in P. K. Robertson and K.L. Cabal, Guide to Cone Penetration Testing for Geotechnical Engineering. The interpretations are presented only as a guide for geotechnical use, and should be carefully reviewed by the user. No warranty is provided as to the correctness or the applicability of any of the geotechnical soil and design parameters shown and does not assume any liability for any use of the results in any design or review. The user should be fully aware of the techniques and limitations of any method used to derive data shown in this report.	Remarks Sheet 1 of 1
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Client:	Eliot Sinclair & Partners Ltd	Bore No.:	CPTu002
Project:	518 Rangiora Woodend Road, Rangiora	Job No.:	21758

Site Location: 518 Rangiora Woodend Road, Rangiora	Date: 1/8/2023
Grid Reference: 1569219.7m E, 5206032.15m N (NZTM) - Handheld GPS	Rig Operator: E. Diaz Farias
Elevation: 0.00m	Datum: Ground
	Equipment: Geomil Panther 100



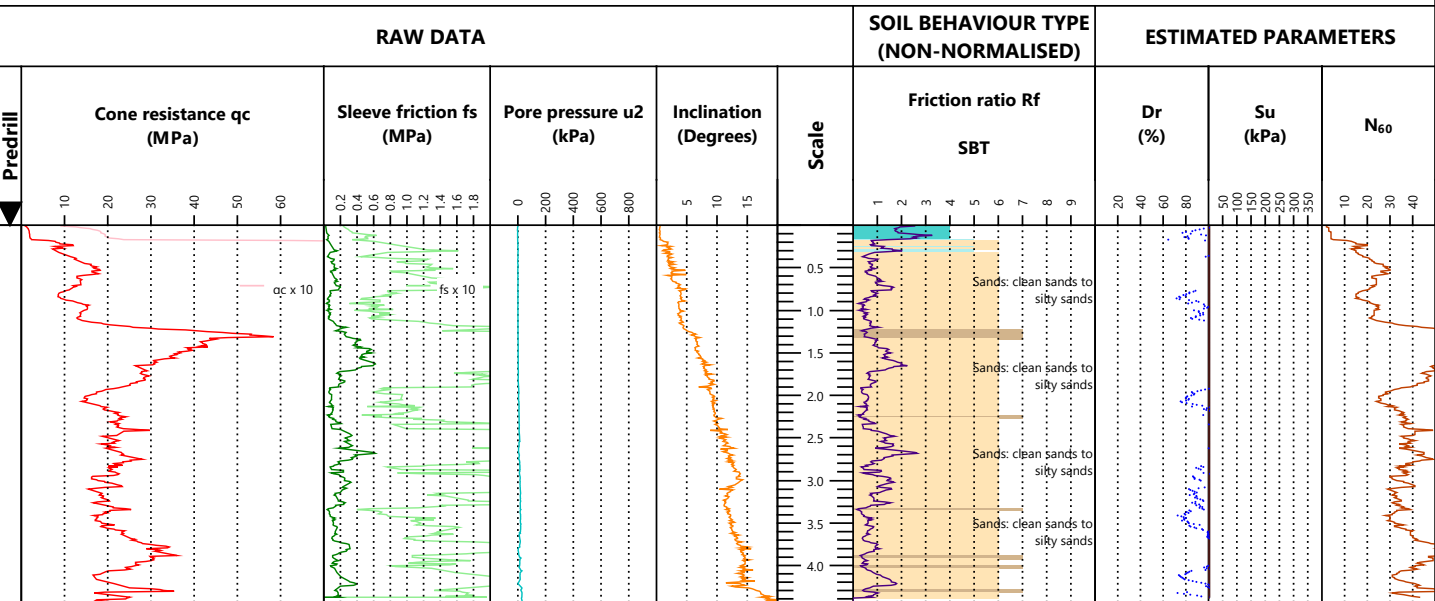
Cone Type: Pagani Piezocone - Compression Cone Reference: MKS364 Cone Area Ratio: 0.79 Standards: ISO 22476-1:2012 - Application Class 2			Predrill: - Water Level: 1.58m Collapse: 1.90m		Termination Target Depth <input type="checkbox"/> Effective Refusal Tip <input checked="" type="checkbox"/> Gauge <input type="checkbox"/> Inclinometer <input type="checkbox"/> Other <input type="checkbox"/>		Soil Behaviour Type (SBT) - Robertson et al. 1986 0 Undefined 1 Sensitive fine-grained 2 Clay - organic soil 3 Clays: clay to silty clay 4 Silt mixtures: clayey silt & silty clay 5 Sand mixtures: silty sand to sandy silt 6 Sands: clean sands to silty sands 7 Dense sand to gravelly sand 8 Stiff sand to clayey sand 9 Stiff fine-grained		
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Zero load outputs (MPa)	Before test	After test
Tip Resistance	24.3623	24.2736
Local Friction	0.2564	0.2569
Pore Pressure	2.9480	2.9455

Notes & Limitations Data shown on this report has been assessed to provide a basic interpretation in terms of Soil Behaviour Type (SBT) and various geotechnical soil and design parameters using methods published in P. K. Robertson and K.L. Cabal, Guide to Cone Penetration Testing for Geotechnical Engineering. The interpretations are presented only as a guide for geotechnical use, and should be carefully reviewed by the user. No warranty is provided as to the correctness or the applicability of any of the geotechnical soil and design parameters shown and does not assume any liability for any use of the results in any design or review. The user should be fully aware of the techniques and limitations of any method used to derive data shown in this report.	Remarks Sheet 1 of 1
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Client:	Eliot Sinclair & Partners Ltd	Bore No.:	CPTu003
Project:	518 Rangiora Woodend Road, Rangiora	Job No.:	21758

Site Location: 518 Rangiora Woodend Road, Rangiora	Date: 1/8/2023
Grid Reference: 1569309.13m E, 5205968.59m N (NZTM) - Handheld GPS	Rig Operator: E. Diaz Farias
Elevation: 0.00m	Datum: Ground
	Equipment: Geomil Panther 100



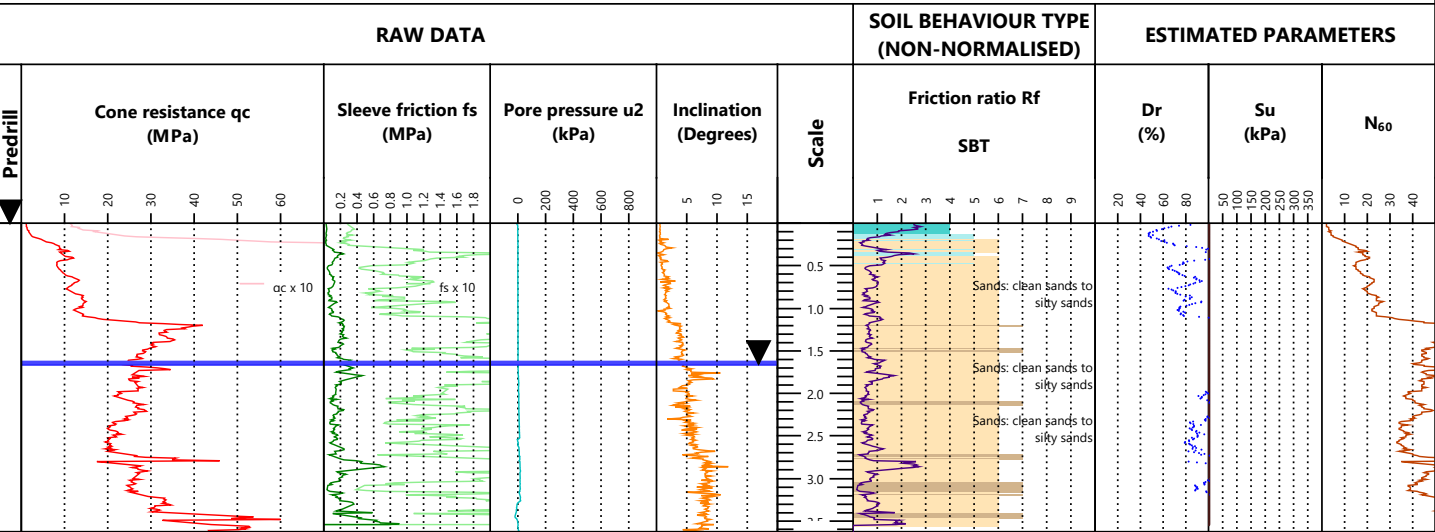
EOH: 4.45m

Cone Type: Pagani Piezocone - Compression Cone Reference: 000328 Cone Area Ratio: 0.79 Standards: ISO 22476-1:2012 - Application Class 2	Predrill: - Water Level: - Collapse: 1.30m	Termination Target Depth <input type="checkbox"/> Effective Refusal Tip <input type="checkbox"/> Gauge <input type="checkbox"/> Inclinometer <input checked="" type="checkbox"/> Other <input type="checkbox"/>	Soil Behaviour Type (SBT) - Robertson et al. 1986 0 Undefined 1 Sensitive fine-grained 2 Clay - organic soil 3 Clays: clay to silty clay 4 Silt mixtures: clayey silt & silty clay 5 Sand mixtures: silty sand to sandy silt 6 Sands: clean sands to silty sands 7 Dense sand to gravelly sand 8 Stiff sand to clayey sand 9 Stiff fine-grained												
<table border="1"> <thead> <tr> <th>Zero load outputs (MPa)</th> <th>Before test</th> <th>After test</th> </tr> </thead> <tbody> <tr> <td>Tip Resistance</td> <td>28.6852</td> <td>28.6903</td> </tr> <tr> <td>Local Friction</td> <td>0.2388</td> <td>0.2394</td> </tr> <tr> <td>Pore Pressure</td> <td>2.9794</td> <td>2.9783</td> </tr> </tbody> </table>	Zero load outputs (MPa)	Before test	After test	Tip Resistance	28.6852	28.6903	Local Friction	0.2388	0.2394	Pore Pressure	2.9794	2.9783			
Zero load outputs (MPa)	Before test	After test													
Tip Resistance	28.6852	28.6903													
Local Friction	0.2388	0.2394													
Pore Pressure	2.9794	2.9783													

Notes & Limitations Data shown on this report has been assessed to provide a basic interpretation in terms of Soil Behaviour Type (SBT) and various geotechnical soil and design parameters using methods published in P. K. Robertson and K.L. Cabal, Guide to Cone Penetration Testing for Geotechnical Engineering. The interpretations are presented only as a guide for geotechnical use, and should be carefully reviewed by the user. No warranty is provided as to the correctness or the applicability of any of the geotechnical soil and design parameters shown and does not assume any liability for any use of the results in any design or review. The user should be fully aware of the techniques and limitations of any method used to derive data shown in this report.	Remarks Sheet 1 of 1
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Client:	Eliot Sinclair & Partners Ltd	Bore No.:	CPTu003A
Project:	518 Rangiora Woodend Road, Rangiora	Job No.:	21758

Site Location: 518 Rangiora Woodend Road, Rangiora	Date: 1/8/2023
Grid Reference: 1569311.63m E, 5205972.82m N (NZTM) - Handheld GPS	Rig Operator: E. Diaz Farias
Elevation: 0.00m	Datum: Ground
	Equipment: Geomil Panther 100

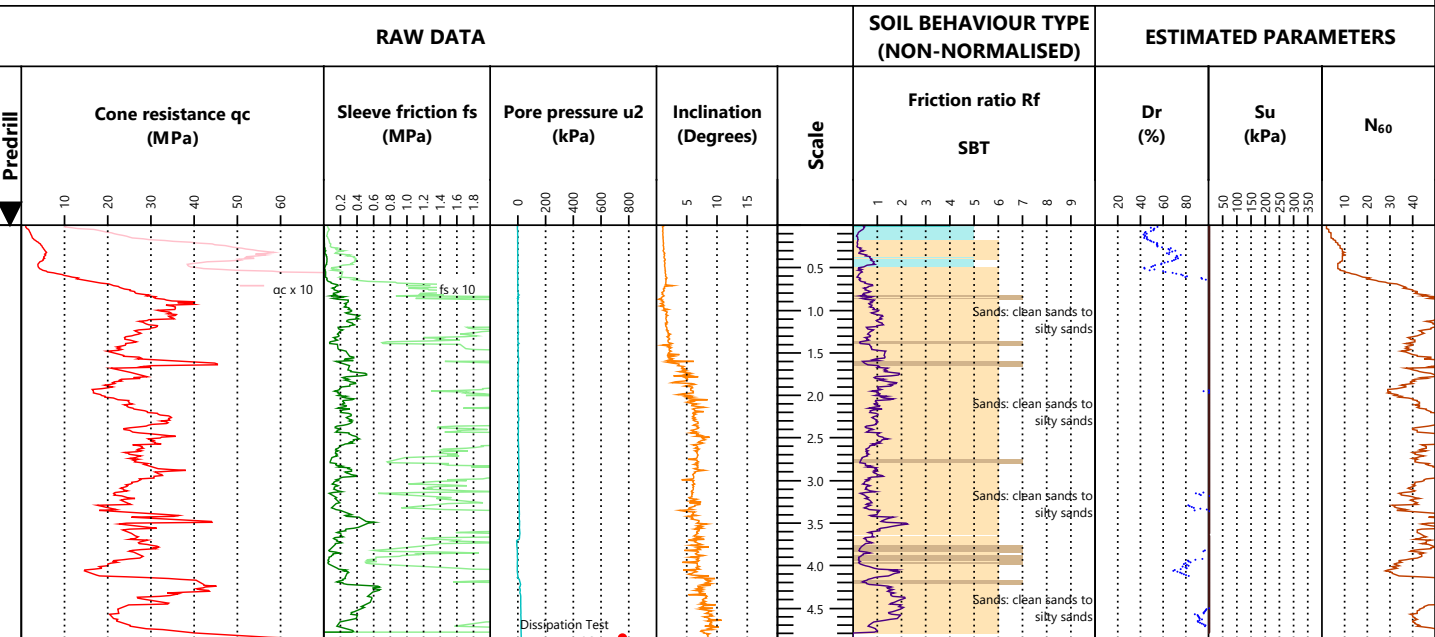


Cone Type: Pagani Piezocone - Compression	Predrill: -	Termination	Soil Behaviour Type (SBT) - Robertson et al. 1986
Cone Reference: MKS364	Water Level: 1.65m	Target Depth <input type="checkbox"/>	0 Undefined
Cone Area Ratio: 0.79	Collapse: 1.70m	Effective Refusal	1 Sensitive fine-grained
Standards: ISO 22476-1:2012 - Application Class 2		Tip <input type="checkbox"/>	2 Clay - organic soil
Zero load outputs (MPa)	Before test	Gauge <input type="checkbox"/>	3 Clays: clay to silty clay
Tip Resistance	24.3101	Inclinometer <input checked="" type="checkbox"/>	4 Silt mixtures: clayey silt & silty clay
Local Friction	0.2567	Other <input type="checkbox"/>	5 Sand mixtures: silty sand to sandy silt
Pore Pressure	2.9479		6 Sands: clean sands to silty sands
	2.9487		7 Dense sand to gravelly sand
			8 Stiff sand to clayey sand
			9 Stiff fine-grained

Notes & Limitations	Remarks
Data shown on this report has been assessed to provide a basic interpretation in terms of Soil Behaviour Type (SBT) and various geotechnical soil and design parameters using methods published in P. K. Robertson and K.L. Cabal, Guide to Cone Penetration Testing for Geotechnical Engineering. The interpretations are presented only as a guide for geotechnical use, and should be carefully reviewed by the user. No warranty is provided as to the correctness or the applicability of any of the geotechnical soil and design parameters shown and does not assume any liability for any use of the results in any design or review. The user should be fully aware of the techniques and limitations of any method used to derive data shown in this report.	
	Sheet 1 of 1

Client:	Eliot Sinclair & Partners Ltd	Bore No.:	CPTu004
Project:	518 Rangiora Woodend Road, Rangiora	Job No.:	21758

Site Location: 518 Rangiora Woodend Road, Rangiora	Date: 1/8/2023
Grid Reference: 1569067.98m E, 5206004.25m N (NZTM) - Handheld GPS	Rig Operator: E. Diaz Farias
Elevation: 0.00m	Datum: Ground
	Equipment: Geomil Panther 100



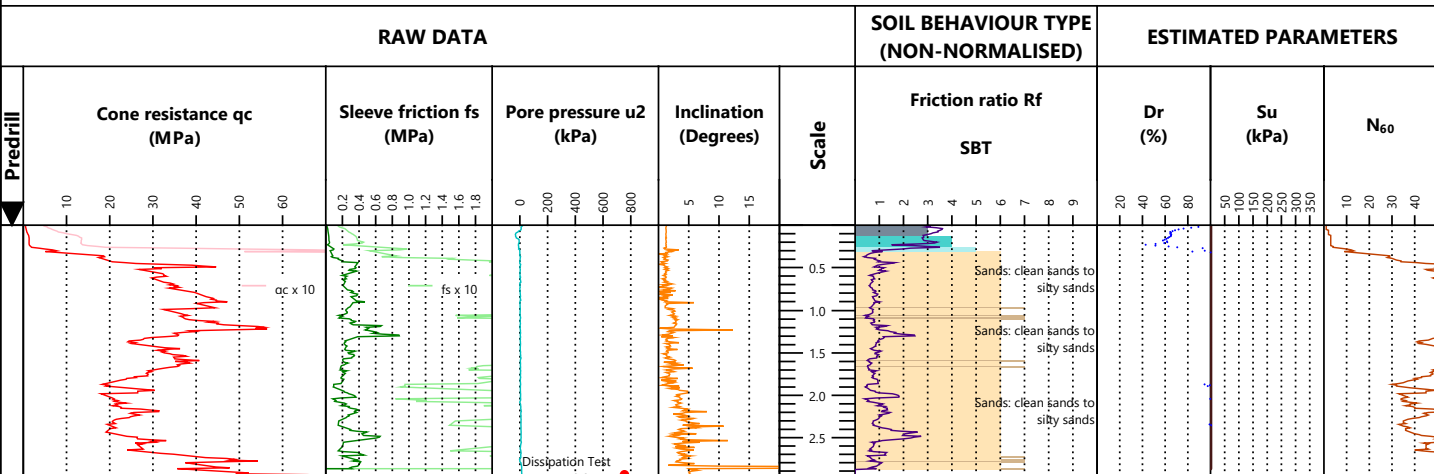
EOH: 4.86m
Dissipation Test: 4.86m, 1500 seconds

Cone Type: Pagani Piezocone - Compression Cone Reference: 000328 Cone Area Ratio: 0.79 Standards: ISO 22476-1:2012 - Application Class 2	Predrill: - Water Level: - Collapse: 2.40m	Termination Target Depth <input type="checkbox"/> Effective Refusal Tip <input checked="" type="checkbox"/> Gauge <input type="checkbox"/> Inclinometer <input type="checkbox"/> Other <input type="checkbox"/>	Soil Behaviour Type (SBT) - Robertson et al. 1986 0 Undefined 1 Sensitive fine-grained 2 Clay - organic soil 3 Clays: clay to silty clay 4 Silt mixtures: clayey silt & silty clay 5 Sand mixtures: silty sand to sandy silt 6 Sands: clean sands to silty sands 7 Dense sand to gravelly sand 8 Stiff sand to clayey sand 9 Stiff fine-grained												
<table border="1"> <thead> <tr> <th>Zero load outputs (MPa)</th> <th>Before test</th> <th>After test</th> </tr> </thead> <tbody> <tr> <td>Tip Resistance</td> <td>28.7056</td> <td>28.6801</td> </tr> <tr> <td>Local Friction</td> <td>0.2376</td> <td>0.2398</td> </tr> <tr> <td>Pore Pressure</td> <td>2.9808</td> <td>2.9779</td> </tr> </tbody> </table>	Zero load outputs (MPa)	Before test	After test	Tip Resistance	28.7056	28.6801	Local Friction	0.2376	0.2398	Pore Pressure	2.9808	2.9779			
Zero load outputs (MPa)	Before test	After test													
Tip Resistance	28.7056	28.6801													
Local Friction	0.2376	0.2398													
Pore Pressure	2.9808	2.9779													

Notes & Limitations Data shown on this report has been assessed to provide a basic interpretation in terms of Soil Behaviour Type (SBT) and various geotechnical soil and design parameters using methods published in P. K. Robertson and K.L. Cabal, Guide to Cone Penetration Testing for Geotechnical Engineering. The interpretations are presented only as a guide for geotechnical use, and should be carefully reviewed by the user. No warranty is provided as to the correctness or the applicability of any of the geotechnical soil and design parameters shown and does not assume any liability for any use of the results in any design or review. The user should be fully aware of the techniques and limitations of any method used to derive data shown in this report.	Remarks Sheet 1 of 1
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Client:	Eliot Sinclair & Partners Ltd	Bore No.:	CPTu005
Project:	518 Rangiora Woodend Road, Rangiora	Job No.:	21758

Site Location: 518 Rangiora Woodend Road, Rangiora	Date: 1/8/2023
Grid Reference: 1569162.23m E, 5205933.16m N (NZTM) - Handheld GPS	Rig Operator: E. Diaz Farias
Elevation: 0.00m	Datum: Ground
	Equipment: Geomil Panther 100



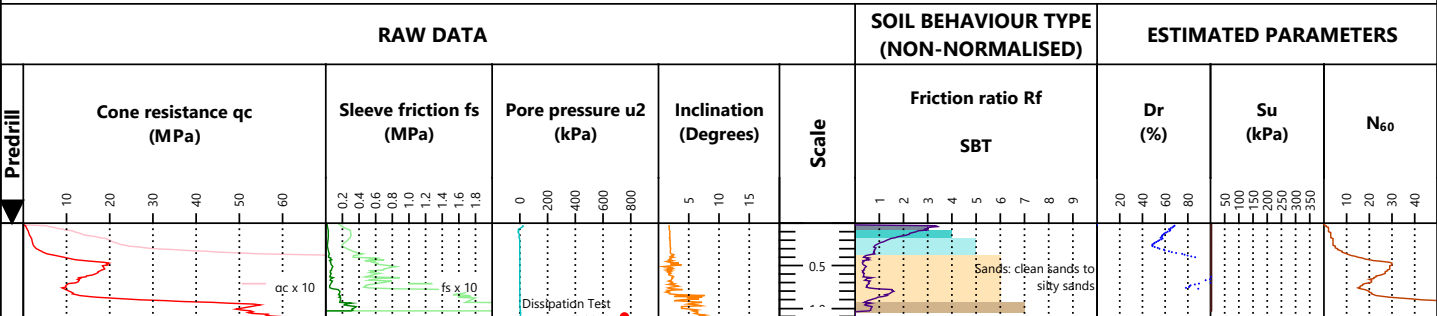
EOH: 2.94m
Dissipation Test 2.94 m 600 seconds

Cone Type: Pagani Piezocone - Compression	Predrill: -	Termination	Soil Behaviour Type (SBT) - Robertson et al. 1986
Cone Reference: MKS364	Water Level: -	Target Depth <input type="checkbox"/>	0 Undefined
Cone Area Ratio: 0.79	Collapse: 1.40m	Effective Refusal	1 Sensitive fine-grained
Standards: ISO 22476-1:2012 - Application Class 2		Tip <input checked="" type="checkbox"/>	2 Clay - organic soil
Zero load outputs (MPa)	Before test	Gauge <input type="checkbox"/>	3 Clays: clay to silty clay
Tip Resistance	24.3466	Inclinometer <input type="checkbox"/>	4 Silt mixtures: clayey silt & silty clay
Local Friction	0.2566	Other <input type="checkbox"/>	5 Sand mixtures: silty sand to sandy silt
Pore Pressure	2.9480		6 Sands: clean sands to silty sands
	2.9463		7 Dense sand to gravelly sand
			8 Stiff sand to clayey sand
			9 Stiff fine-grained

Notes & Limitations	Remarks
Data shown on this report has been assessed to provide a basic interpretation in terms of Soil Behaviour Type (SBT) and various geotechnical soil and design parameters using methods published in P. K. Robertson and K.L. Cabal, Guide to Cone Penetration Testing for Geotechnical Engineering. The interpretations are presented only as a guide for geotechnical use, and should be carefully reviewed by the user. No warranty is provided as to the correctness or the applicability of any of the geotechnical soil and design parameters shown and does not assume any liability for any use of the results in any design or review. The user should be fully aware of the techniques and limitations of any method used to derive data shown in this report.	

Client:	Eliot Sinclair & Partners Ltd	Bore No.:	CPTu006
Project:	518 Rangiora Woodend Road, Rangiora	Job No.:	21758

Site Location: 518 Rangiora Woodend Road, Rangiora	Date: 1/8/2023
Grid Reference: 1569254.15m E, 5205876.6m N (NZTM) - Handheld GPS	Rig Operator: E. Diaz Farias
Elevation: 0.00m	Datum: Ground
	Equipment: Geomil Panther 100

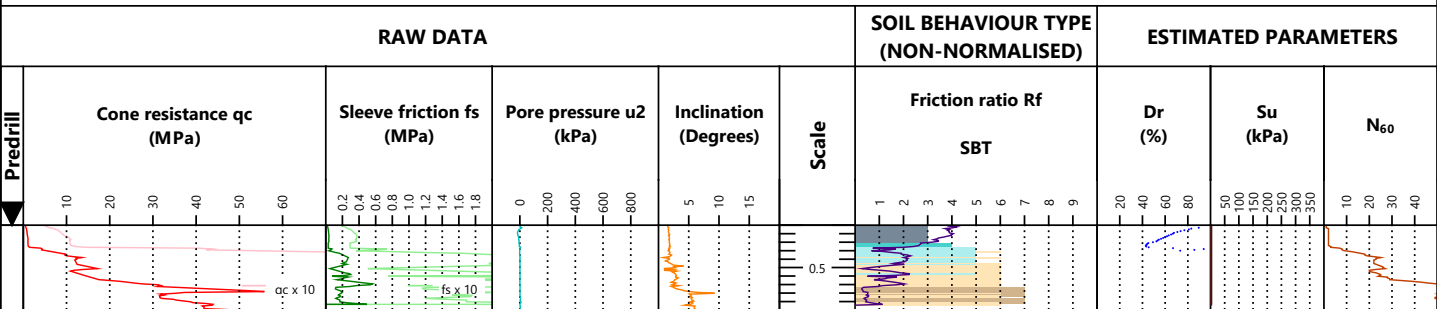


Cone Type: Pagani Piezocone - Compression Cone Reference: MKS364 Cone Area Ratio: 0.79 Standards: ISO 22476-1:2012 - Application Class 2	Predrill: - Water Level: - Collapse: 1.10m	Termination Target Depth <input type="checkbox"/> Effective Refusal Tip <input checked="" type="checkbox"/> Gauge <input type="checkbox"/> Inclinometer <input type="checkbox"/> Other <input type="checkbox"/>	Soil Behaviour Type (SBT) - Robertson et al. 1986 0 Undefined 1 Sensitive fine-grained 2 Clay - organic soil 3 Clays: clay to silty clay 4 Silt mixtures: clayey silt & silty clay 5 Sand mixtures: silty sand to sandy silt 6 Sands: clean sands to silty sands 7 Dense sand to gravelly sand 8 Stiff sand to clayey sand 9 Stiff fine-grained												
<table border="1"> <thead> <tr> <th>Zero load outputs (MPa)</th> <th>Before test</th> <th>After test</th> </tr> </thead> <tbody> <tr> <td>Tip Resistance</td> <td>24.3205</td> <td>24.2370</td> </tr> <tr> <td>Local Friction</td> <td>0.2573</td> <td>0.2563</td> </tr> <tr> <td>Pore Pressure</td> <td>2.9481</td> <td>2.9469</td> </tr> </tbody> </table>	Zero load outputs (MPa)	Before test	After test	Tip Resistance	24.3205	24.2370	Local Friction	0.2573	0.2563	Pore Pressure	2.9481	2.9469			
Zero load outputs (MPa)	Before test	After test													
Tip Resistance	24.3205	24.2370													
Local Friction	0.2573	0.2563													
Pore Pressure	2.9481	2.9469													

Notes & Limitations Data shown on this report has been assessed to provide a basic interpretation in terms of Soil Behaviour Type (SBT) and various geotechnical soil and design parameters using methods published in P. K. Robertson and K.L. Cabal, Guide to Cone Penetration Testing for Geotechnical Engineering. The interpretations are presented only as a guide for geotechnical use, and should be carefully reviewed by the user. No warranty is provided as to the correctness or the applicability of any of the geotechnical soil and design parameters shown and does not assume any liability for any use of the results in any design or review. The user should be fully aware of the techniques and limitations of any method used to derive data shown in this report.	Remarks Sheet 1 of 1
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Client:	Eliot Sinclair & Partners Ltd	Bore No.:	CPTu006A
Project:	518 Rangiora Woodend Road, Rangiora	Job No.:	21758

Site Location: 518 Rangiora Woodend Road, Rangiora	Date: 1/8/2023
Grid Reference: 1569249.5m E, 5205882.69m N (NZTM) - Handheld GPS	Rig Operator: E. Diaz Farias
Elevation: 0.00m	Datum: Ground
	Equipment: Geomil Panther 100



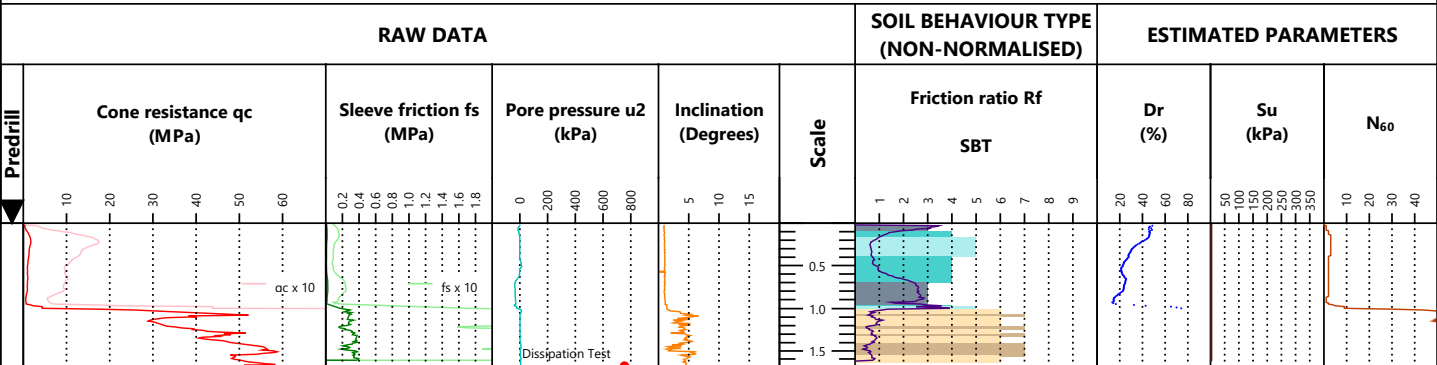
EOH: 1.01m

Cone Type: Pagani Piezocone - Compression	Predrill: -	Termination	Soil Behaviour Type (SBT) - Robertson et al. 1986
Cone Reference: 000328	Water Level: -	Target Depth <input type="checkbox"/>	5 Sand mixtures: silty sand to sandy silt
Cone Area Ratio: 0.79	Collapse: 0.60m	Effective Refusal	6 Sands: clean sands to silty sands
Standards: ISO 22476-1:2012 - Application Class 2		Tip <input checked="" type="checkbox"/>	7 Dense sand to gravelly sand
Zero load outputs (MPa)	Before test	Gauge <input type="checkbox"/>	8 Stiff sand to clayey sand
Tip Resistance	28.6852	Inclinometer <input type="checkbox"/>	9 Stiff fine-grained
Local Friction	0.2371	Other <input type="checkbox"/>	
Pore Pressure	2.9791		
After test	28.6495		
	0.2375		
	2.9794		

Notes & Limitations	Remarks
Data shown on this report has been assessed to provide a basic interpretation in terms of Soil Behaviour Type (SBT) and various geotechnical soil and design parameters using methods published in P. K. Robertson and K.L. Cabal, Guide to Cone Penetration Testing for Geotechnical Engineering. The interpretations are presented only as a guide for geotechnical use, and should be carefully reviewed by the user. No warranty is provided as to the correctness or the applicability of any of the geotechnical soil and design parameters shown and does not assume any liability for any use of the results in any design or review. The user should be fully aware of the techniques and limitations of any method used to derive data shown in this report.	

Client:	Eliot Sinclair & Partners Ltd	Bore No.:	CPTu007
Project:	518 Rangiora Woodend Road, Rangiora	Job No.:	21758

Site Location: 518 Rangiora Woodend Road, Rangiora	Date: 2/8/2023
Grid Reference: 1568965.5m E, 5205885.95m N (NZTM) - Handheld GPS	Rig Operator: E. Diaz Farias
Elevation: 0.00m	Datum: Ground
	Equipment: Geomil Panther 100

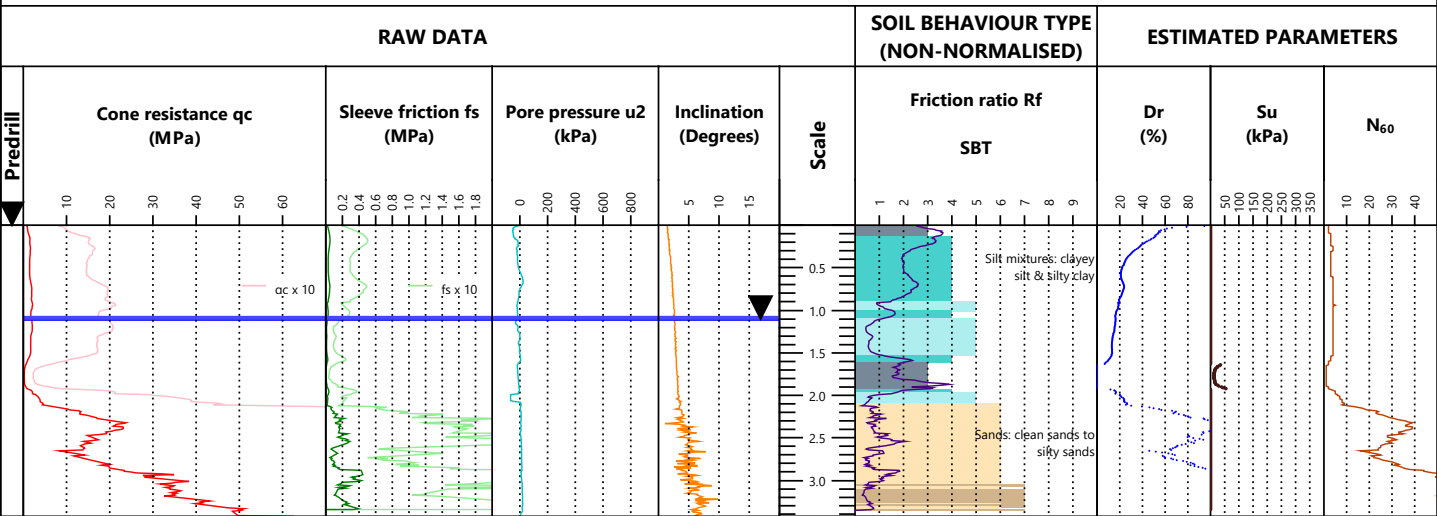


Cone Type: Pagani Piezocone - Compression	Predrill: -	Termination	Soil Behaviour Type (SBT) - Robertson et al. 1986
Cone Reference: MKS364	Water Level: -	Target Depth <input type="checkbox"/>	5 Sand mixtures: silty sand to sandy silt
Cone Area Ratio: 0.79	Collapse: 1.50m	Effective Refusal	6 Sands: clean sands to silty sands
Standards: ISO 22476-1:2012 - Application Class 2		Tip <input checked="" type="checkbox"/>	7 Dense sand to gravelly sand
Zero load outputs (MPa)	Before test	Gauge <input type="checkbox"/>	8 Stiff sand to clayey sand
Tip Resistance	24.2110	Inclinometer <input type="checkbox"/>	9 Stiff fine-grained
Local Friction	0.2564	Other <input type="checkbox"/>	
Pore Pressure	2.9480		
After test	24.2527		
	0.2563		
	2.9491		

Notes & Limitations	Remarks
Data shown on this report has been assessed to provide a basic interpretation in terms of Soil Behaviour Type (SBT) and various geotechnical soil and design parameters using methods published in P. K. Robertson and K.L. Cabal, Guide to Cone Penetration Testing for Geotechnical Engineering. The interpretations are presented only as a guide for geotechnical use, and should be carefully reviewed by the user. No warranty is provided as to the correctness or the applicability of any of the geotechnical soil and design parameters shown and does not assume any liability for any use of the results in any design or review. The user should be fully aware of the techniques and limitations of any method used to derive data shown in this report.	
	Sheet 1 of 1

Client:	Eliot Sinclair & Partners Ltd	Bore No.:	CPTu008
Project:	518 Rangiora Woodend Road, Rangiora	Job No.:	21758

Site Location: 518 Rangiora Woodend Road, Rangiora	Date: 31/7/2023
Grid Reference: 1569095.12m E, 5205815.02m N (NZTM) - Handheld GPS	Rig Operator: E. Diaz Farias
Elevation: 0.00m	Datum: Ground
	Equipment: Geomil Panther 100



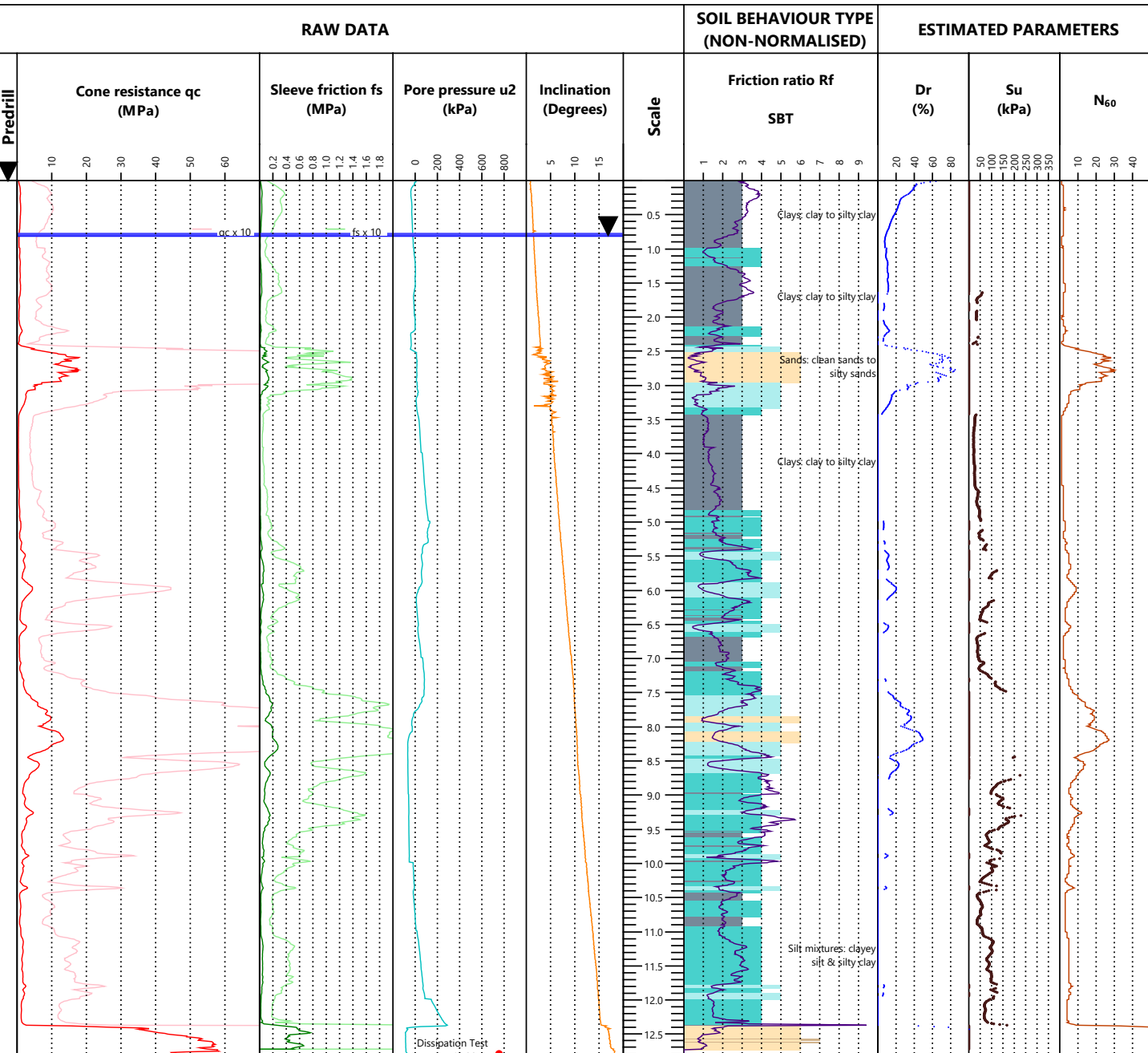
<p>Cone Type: Pagani Piezocone - Compression</p> <p>Cone Reference: MKS364</p> <p>Cone Area Ratio: 0.79</p> <p>Standards: ISO 22476-1:2012 - Application Class 2</p>																																						
<p>Zero load outputs (MPa)</p> <table border="1"> <tr> <th>Before test</th> <th>After test</th> </tr> <tr> <td>Tip Resistance</td> <td>24.3623</td> </tr> <tr> <td>Local Friction</td> <td>0.2557</td> </tr> <tr> <td>Pore Pressure</td> <td>2.9490</td> </tr> </table>			Before test	After test	Tip Resistance	24.3623	Local Friction	0.2557	Pore Pressure	2.9490	<p>Predrill: -</p> <p>Water Level: 1.10m</p> <p>Collapse: 1.80m</p>			<p>Termination</p> <p>Target Depth <input type="checkbox"/></p>		<p>Soil Behaviour Type (SBT) - Robertson et al. 1986</p> <table border="1"> <tr> <td>0</td> <td>Undefined</td> <td>5</td> <td>Sand mixtures: silty sand to sandy silt</td> </tr> <tr> <td>1</td> <td>Sensitive fine-grained</td> <td>6</td> <td>Sands: clean sands to silty sands</td> </tr> <tr> <td>2</td> <td>Clay - organic soil</td> <td>7</td> <td>Dense sand to gravelly sand</td> </tr> <tr> <td>3</td> <td>Clays: clay to silty clay</td> <td>8</td> <td>Stiff sand to clayey sand</td> </tr> <tr> <td>4</td> <td>Silt mixtures: clayey silt & silty clay</td> <td>9</td> <td>Stiff fine-grained</td> </tr> </table>			0	Undefined	5	Sand mixtures: silty sand to sandy silt	1	Sensitive fine-grained	6	Sands: clean sands to silty sands	2	Clay - organic soil	7	Dense sand to gravelly sand	3	Clays: clay to silty clay	8	Stiff sand to clayey sand	4	Silt mixtures: clayey silt & silty clay	9	Stiff fine-grained
Before test	After test																																					
Tip Resistance	24.3623																																					
Local Friction	0.2557																																					
Pore Pressure	2.9490																																					
0	Undefined	5	Sand mixtures: silty sand to sandy silt																																			
1	Sensitive fine-grained	6	Sands: clean sands to silty sands																																			
2	Clay - organic soil	7	Dense sand to gravelly sand																																			
3	Clays: clay to silty clay	8	Stiff sand to clayey sand																																			
4	Silt mixtures: clayey silt & silty clay	9	Stiff fine-grained																																			

<p>Effective Refusal</p> <p>Tip <input checked="" type="checkbox"/></p> <p>Gauge <input type="checkbox"/></p> <p>Inclinometer <input type="checkbox"/></p> <p>Other <input type="checkbox"/></p>									
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<p>Notes & Limitations</p> <p>Data shown on this report has been assessed to provide a basic interpretation in terms of Soil Behaviour Type (SBT) and various geotechnical soil and design parameters using methods published in P. K. Robertson and K.L. Cabal, Guide to Cone Penetration Testing for Geotechnical Engineering. The interpretations are presented only as a guide for geotechnical use, and should be carefully reviewed by the user. No warranty is provided as to the correctness or the applicability of any of the geotechnical soil and design parameters shown and does not assume any liability for any use of the results in any design or review. The user should be fully aware of the techniques and limitations of any method used to derive data shown in this report.</p>								<p>Remarks</p>	
<p>Sheet 1 of 1</p>									

Client:	Eliot Sinclair & Partners Ltd	Bore No.:	CPTu009
Project:	518 Rangiora Woodend Road, Rangiora	Job No.:	21758

Site Location: 518 Rangiora Woodend Road, Rangiora	Date: 31/7/2023
Grid Reference: 1569200.26m E, 5205756.97m N (NZTM) - Handheld GPS	Rig Operator: E. Diaz Farias
Elevation: 0.00m	Datum: Ground
	Equipment: Geomil Panther 100



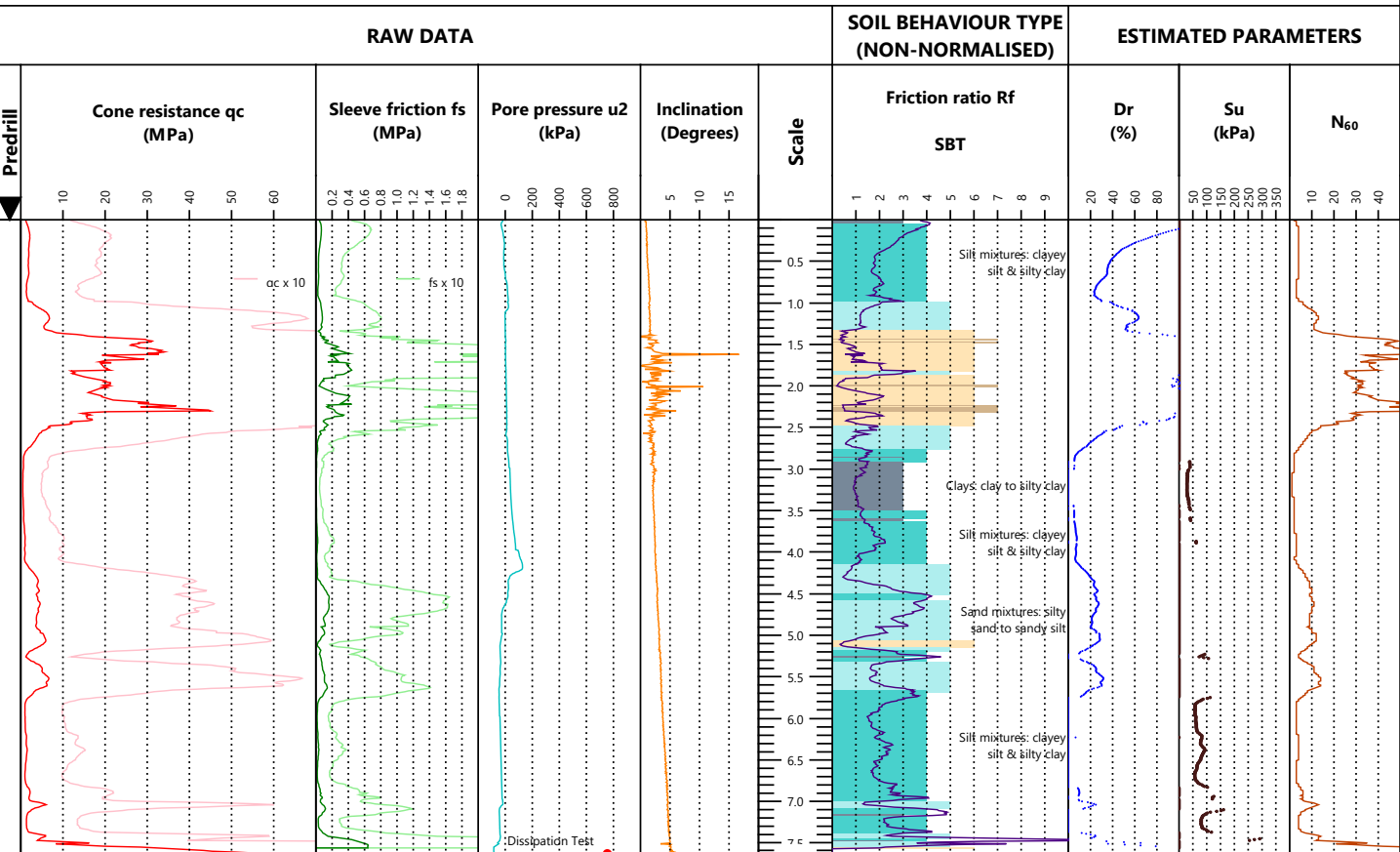
EOH: 12.8m
1500 seconds

Cone Type: Pagani Piezocone - Compression	Predrill: -	Termination	Soil Behaviour Type (SBT) - Robertson et al. 1986
Cone Reference: 000328	Water Level: 0.80m	Target Depth <input type="checkbox"/>	0 Undefined
Cone Area Ratio: 0.79	Collapse: 2.30m	Effective Refusal	1 Sensitive fine-grained
Standards: ISO 22476-1:2012 - Application Class 2		Tip <input type="checkbox"/>	2 Clay - organic soil
Zero load outputs (MPa)	Before test	Gauge <input checked="" type="checkbox"/>	3 Clays: clay to silty clay
Tip Resistance	28.7312	Inclinometer <input type="checkbox"/>	4 Silt mixtures: clayey silt & silty clay
Local Friction	0.2382	Other <input type="checkbox"/>	5 Sand mixtures: silty sand to sandy silt
Pore Pressure	2.9804		6 Sands: clean sands to silty sands
	2.9790		7 Dense sand to gravelly sand
			8 Stiff sand to clayey sand
			9 Stiff fine-grained

Notes & Limitations	Remarks
Data shown on this report has been assessed to provide a basic interpretation in terms of Soil Behaviour Type (SBT) and various geotechnical soil and design parameters using methods published in P. K. Robertson and K.L. Cabal, Guide to Cone Penetration Testing for Geotechnical Engineering. The interpretations are presented only as a guide for geotechnical use, and should be carefully reviewed by the user. No warranty is provided as to the correctness or the applicability of any of the geotechnical soil and design parameters shown and does not assume any liability for any use of the results in any design or review. The user should be fully aware of the techniques and limitations of any method used to derive data shown in this report.	

Client:	Eliot Sinclair & Partners Ltd	Bore No.:	CPTu010
Project:	518 Rangiora Woodend Road, Rangiora	Job No.:	21758

Site Location: 518 Rangiora Woodend Road, Rangiora	Date: 31/7/2023
Grid Reference: 1568924.24m E, 5205740.05m N (NZTM) - Handheld GPS	Rig Operator: E. Diaz Farias
Elevation: 0.00m	Datum: Ground
	Equipment: Geomil Panther 100



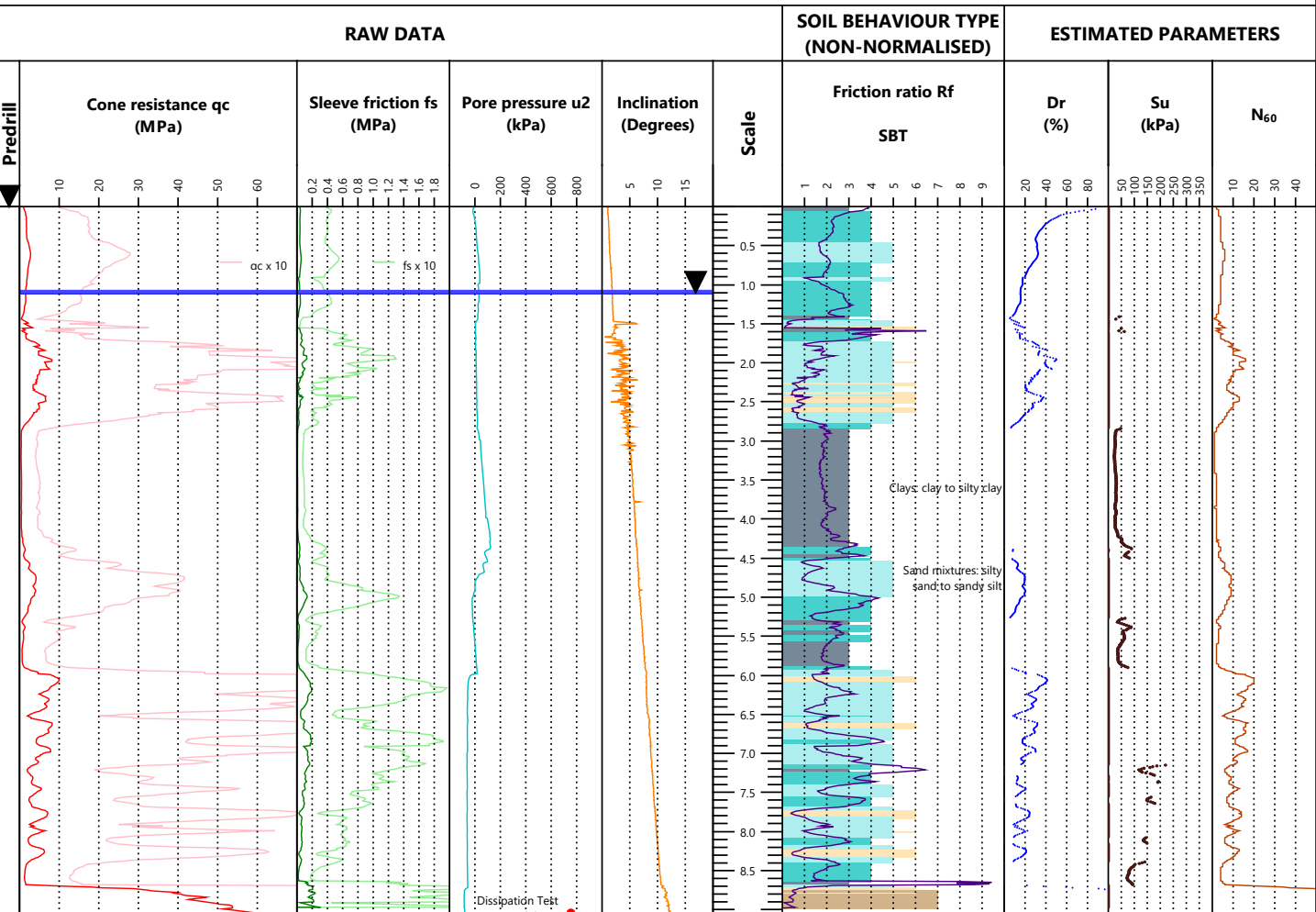
EOH: 7.64m
 Dissipation Test 7.64 m
 900 seconds

Cone Type: Pagani Piezocone - Compression	Predrill: -	Termination	Soil Behaviour Type (SBT) - Robertson et al. 1986
Cone Reference: MKS364	Water Level: -	Target Depth <input type="checkbox"/>	5 Sand mixtures: silty sand to sandy silt
Cone Area Ratio: 0.79	Collapse: 1.55m	Effective Refusal	6 Sands: clean sands to silty sands
Standards: ISO 22476-1:2012 - Application Class 2		Tip <input checked="" type="checkbox"/>	7 Dense sand to gravelly sand
Zero load outputs (MPa)	Before test	Gauge <input type="checkbox"/>	8 Stiff sand to clayey sand
Tip Resistance	24.1901	Inclinometer <input type="checkbox"/>	9 Stiff fine-grained
Local Friction	0.2563	Other <input type="checkbox"/>	
Pore Pressure	2.9439		
After test	24.2892		
	0.2564		
	2.9464		

Notes & Limitations	Remarks
Data shown on this report has been assessed to provide a basic interpretation in terms of Soil Behaviour Type (SBT) and various geotechnical soil and design parameters using methods published in P. K. Robertson and K.L. Cabal, Guide to Cone Penetration Testing for Geotechnical Engineering. The interpretations are presented only as a guide for geotechnical use, and should be carefully reviewed by the user. No warranty is provided as to the correctness or the applicability of any of the geotechnical soil and design parameters shown and does not assume any liability for any use of the results in any design or review. The user should be fully aware of the techniques and limitations of any method used to derive data shown in this report.	

Client:	Eliot Sinclair & Partners Ltd	Bore No.:	CPTu011
Project:	518 Rangiora Woodend Road, Rangiora	Job No.:	21758

Site Location: 518 Rangiora Woodend Road, Rangiora	Date: 31/7/2023
Grid Reference: 1569022.2m E, 5205690.42m N (NZTM) - Handheld GPS	Rig Operator: E. Diaz Farias
Elevation: 0.00m	Datum: Ground
	Equipment: Geomil Panther 100



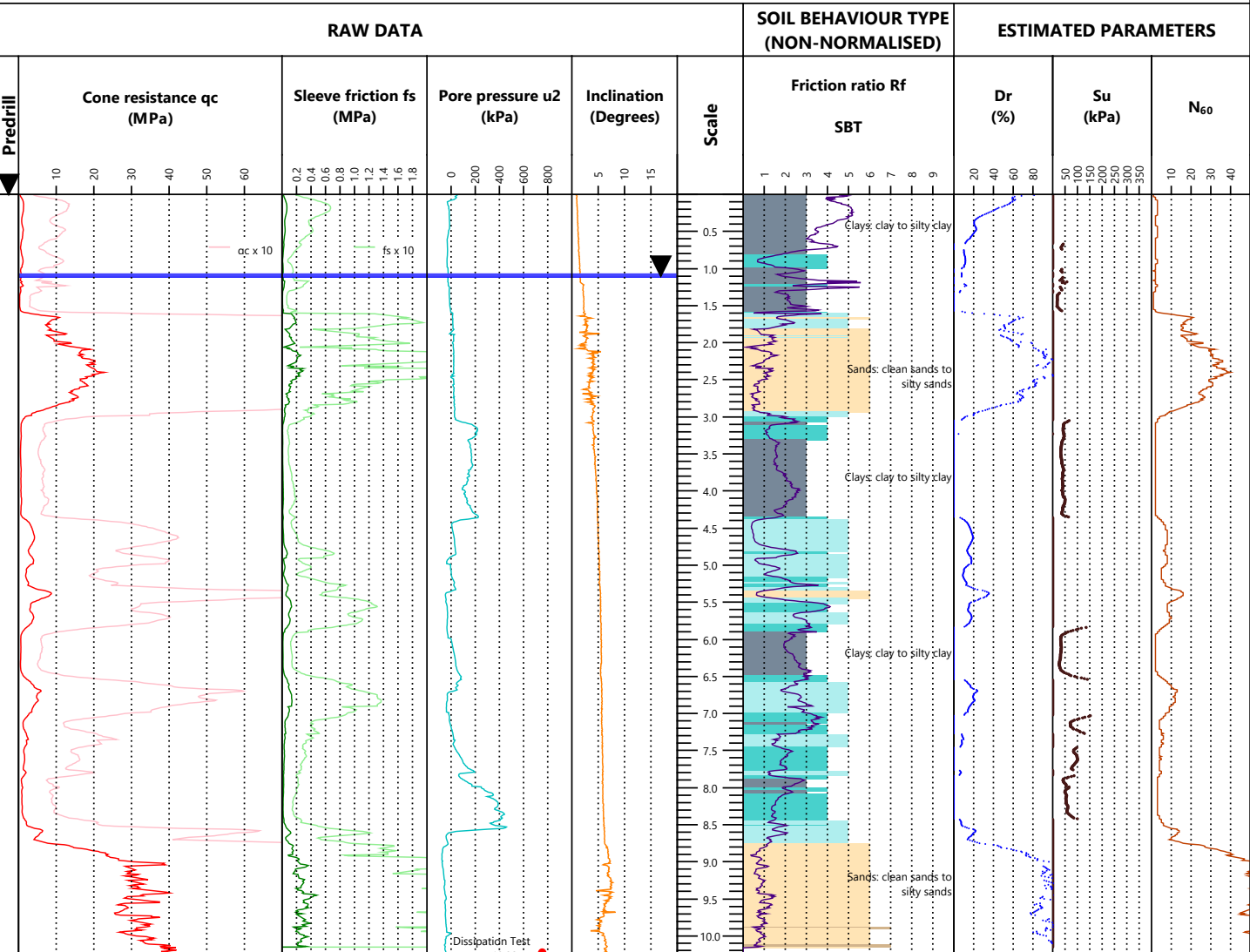
EOH: 9.05m
1200 seconds

Cone Type: Pagani Piezocone - Compression Cone Reference: MKS364 Cone Area Ratio: 0.79 Standards: ISO 22476-1:2012 - Application Class 2	Predrill: - Water Level: 1.10m Collapse: 1.80m	Termination Target Depth <input type="checkbox"/> Effective Refusal Tip <input checked="" type="checkbox"/> Gauge <input type="checkbox"/> Inclinometer <input type="checkbox"/> Other <input type="checkbox"/>	Soil Behaviour Type (SBT) - Robertson et al. 1986 0 Undefined 1 Sensitive fine-grained 2 Clay - organic soil 3 Clays: clay to silty clay 4 Silt mixtures: clayey silt & silty clay 5 Sand mixtures: silty sand to sandy silt 6 Sands: clean sands to silty sands 7 Dense sand to gravelly sand 8 Stiff sand to clayey sand 9 Stiff fine-grained
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Notes & Limitations Data shown on this report has been assessed to provide a basic interpretation in terms of Soil Behaviour Type (SBT) and various geotechnical soil and design parameters using methods published in P. K. Robertson and K.L. Cabal, Guide to Cone Penetration Testing for Geotechnical Engineering. The interpretations are presented only as a guide for geotechnical use, and should be carefully reviewed by the user. No warranty is provided as to the correctness or the applicability of any of the geotechnical soil and design parameters shown and does not assume any liability for any use of the results in any design or review. The user should be fully aware of the techniques and limitations of any method used to derive data shown in this report.	Remarks Sheet 1 of 1
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Client:	Eliot Sinclair & Partners Ltd	Bore No.:	CPTu012
Project:	518 Rangiora Woodend Road, Rangiora	Job No.:	21758

Site Location: 518 Rangiora Woodend Road, Rangiora	Date: 31/7/2023
Grid Reference: 1569132.1m E, 5205639.28m N (NZTM) - Handheld GPS	Rig Operator: E. Diaz Farias
Elevation: 0.00m	Datum: Ground
	Equipment: Geomil Panther 100



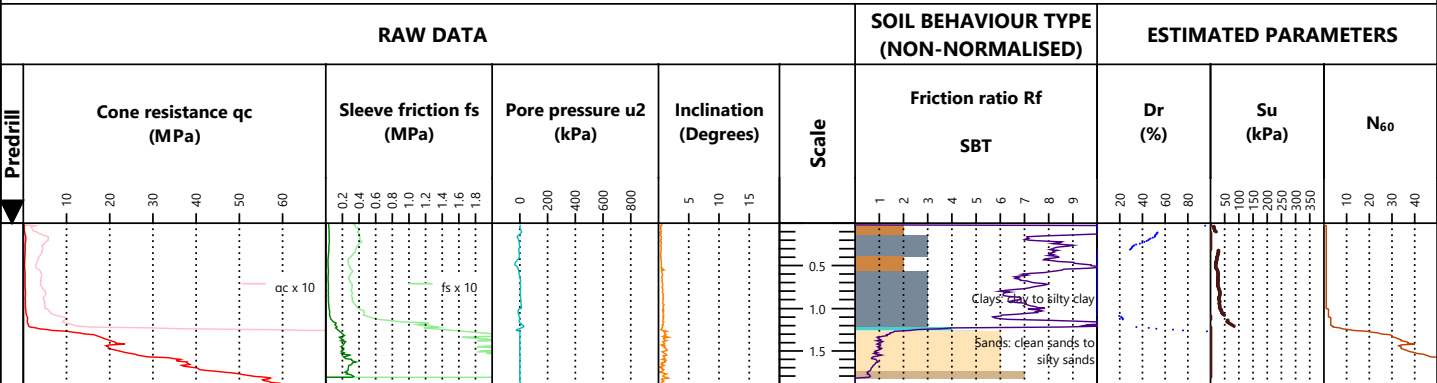
EOH: 10.23m
1200 seconds

Cone Type: Pagani Piezocone - Compression	Predrill: -	Termination	Soil Behaviour Type (SBT) - Robertson et al. 1986
Cone Reference: 000328	Water Level: 1.10m	Target Depth <input checked="" type="checkbox"/>	5 Sand mixtures: silty sand to sandy silt
Cone Area Ratio: 0.79	Collapse: 1.80m	Effective Refusal	6 Sands: clean sands to silty sands
Standards: ISO 22476-1:2012 - Application Class 2		Tip <input type="checkbox"/>	7 Dense sand to gravelly sand
Zero load outputs (MPa)	Before test	Gauge <input type="checkbox"/>	8 Stiff sand to clayey sand
Tip Resistance	28.6699	Inclinometer <input type="checkbox"/>	9 Stiff fine-grained
Local Friction	0.2393	Other <input type="checkbox"/>	
Pore Pressure	2.9797		
After test	28.6954		
	0.2393		
	2.9791		

Notes & Limitations		Remarks
Data shown on this report has been assessed to provide a basic interpretation in terms of Soil Behaviour Type (SBT) and various geotechnical soil and design parameters using methods published in P. K. Robertson and K.L. Cabal, Guide to Cone Penetration Testing for Geotechnical Engineering. The interpretations are presented only as a guide for geotechnical use, and should be carefully reviewed by the user. No warranty is provided as to the correctness or the applicability of any of the geotechnical soil and design parameters shown and does not assume any liability for any use of the results in any design or review. The user should be fully aware of the techniques and limitations of any method used to derive data shown in this report.		

Client:	Eliot Sinclair & Partners Ltd	Bore No.:	CPTu013
Project:	518 Rangiora Woodend Road, Rangiora	Job No.:	21758

Site Location: 518 Rangiora Woodend Road, Rangiora	Date: 1/8/2023
Grid Reference: 1568898.88m E, 5205875.76m N (NZTM) - Handheld GPS	Rig Operator: E. Diaz Farias
Elevation: 0.00m	Datum: Ground
	Equipment: Geomil Panther 100



EOH: 1.89m

Cone Type: Pagani Piezocone - Compression Cone Reference: MKS364 Cone Area Ratio: 0.79 Standards: ISO 22476-1:2012 - Application Class 2	Predrill: - Water Level: - Collapse: 1.70m	Termination Target Depth <input type="checkbox"/> Effective Refusal Tip <input checked="" type="checkbox"/> Gauge <input type="checkbox"/> Inclinometer <input type="checkbox"/> Other <input type="checkbox"/>	Soil Behaviour Type (SBT) - Robertson et al. 1986 0 Undefined 1 Sensitive fine-grained 2 Clay - organic soil 3 Clays: clay to silty clay 4 Silt mixtures: clayey silt & silty clay 5 Sand mixtures: silty sand to sandy silt 6 Sands: clean sands to silty sands 7 Dense sand to gravelly sand 8 Stiff sand to clayey sand 9 Stiff fine-grained
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Notes & Limitations Data shown on this report has been assessed to provide a basic interpretation in terms of Soil Behaviour Type (SBT) and various geotechnical soil and design parameters using methods published in P. K. Robertson and K.L. Cabal, Guide to Cone Penetration Testing for Geotechnical Engineering. The interpretations are presented only as a guide for geotechnical use, and should be carefully reviewed by the user. No warranty is provided as to the correctness or the applicability of any of the geotechnical soil and design parameters shown and does not assume any liability for any use of the results in any design or review. The user should be fully aware of the techniques and limitations of any method used to derive data shown in this report.	Remarks Sheet 1 of 1
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TEST DETAIL

PointID: CPTu001

Sounding: 1

Operator: E. Diaz Farias

Cone Type: Pagani Piezocone - Compression

Cone Reference: MKS364

Cone Area Ratio: 0.79

Zero load outputs (MPa)	Before test	After test
Tip Resistance	24.3466	24.3518
Local Friction	0.2561	0.2563
Pore Pressure	2.9479	2.9484

Date: 1/8/2023

Predrill: 0.00m

Water Level: -

Collapse: 1.70m

Termination

Target Depth

Effective Refusal

Tip
Gauge
Inclinometer
Other

PointID: CPTu002

Sounding: 1

Operator: E. Diaz Farias

Cone Type: Pagani Piezocone - Compression

Cone Reference: MKS364

Cone Area Ratio: 0.79

Zero load outputs (MPa)	Before test	After test
Tip Resistance	24.3623	24.2736
Local Friction	0.2564	0.2569
Pore Pressure	2.9480	2.9455

Date: 1/8/2023

Predrill: 0.00m

Water Level: 1.58m

Collapse: 1.90m

Termination

Target Depth

Effective Refusal

Tip
Gauge
Inclinometer
Other

PointID: CPTu003

Sounding: 1

Operator: E. Diaz Farias

Cone Type: Pagani Piezocone - Compression

Cone Reference: 000328

Cone Area Ratio: 0.79

Zero load outputs (MPa)	Before test	After test
Tip Resistance	28.6852	28.6903
Local Friction	0.2388	0.2394
Pore Pressure	2.9794	2.9783

Date: 1/8/2023

Predrill: 0.00m

Water Level: -

Collapse: 1.30m

Termination

Target Depth

Effective Refusal

Tip
Gauge
Inclinometer
Other

PointID: CPTu003A

Sounding: 1

Operator: E. Diaz Farias

Cone Type: Pagani Piezocone - Compression

Cone Reference: MKS364

Cone Area Ratio: 0.79

Zero load outputs (MPa)	Before test	After test
Tip Resistance	24.3101	24.3518
Local Friction	0.2567	0.2564
Pore Pressure	2.9479	2.9487

Date: 1/8/2023

Predrill: 0.00m

Water Level: 1.65m

Collapse: 1.70m

Termination

Target Depth

Effective Refusal

Tip
Gauge
Inclinometer
Other

PointID: CPTu004

Sounding: 1

Operator: E. Diaz Farias

Cone Type: Pagani Piezocone - Compression

Cone Reference: 000328

Cone Area Ratio: 0.79

Zero load outputs (MPa)	Before test	After test
Tip Resistance	28.7056	28.6801
Local Friction	0.2376	0.2398
Pore Pressure	2.9808	2.9779

Date: 1/8/2023

Predrill: 0.00m

Water Level: -

Collapse: 2.40m

Termination

Target Depth

Effective Refusal

Tip
Gauge
Inclinometer
Other

TEST DETAIL

PointID: CPTu005

Sounding: 1

Operator: E. Diaz Farias

Cone Type: Pagani Piezocone - Compression

Cone Reference: MKS364

Cone Area Ratio: 0.79

Zero load outputs (MPa)	Before test	After test
Tip Resistance	24.3466	24.2736
Local Friction	0.2566	0.2569
Pore Pressure	2.9480	2.9463

Date: 1/8/2023

Predrill: 0.00m

Water Level: -

Collapse: 1.40m

Termination

Target Depth

Effective Refusal

- Tip
- Gauge
- Inclinometer
- Other

PointID: CPTu006

Sounding: 1

Operator: E. Diaz Farias

Cone Type: Pagani Piezocone - Compression

Cone Reference: MKS364

Cone Area Ratio: 0.79

Zero load outputs (MPa)	Before test	After test
Tip Resistance	24.3205	24.2370
Local Friction	0.2573	0.2563
Pore Pressure	2.9481	2.9469

Date: 1/8/2023

Predrill: 0.00m

Water Level: -

Collapse: 1.10m

Termination

Target Depth

Effective Refusal

- Tip
- Gauge
- Inclinometer
- Other

PointID: CPTu006A

Sounding: 1

Operator: E. Diaz Farias

Cone Type: Pagani Piezocone - Compression

Cone Reference: 000328

Cone Area Ratio: 0.79

Zero load outputs (MPa)	Before test	After test
Tip Resistance	28.6852	28.6495
Local Friction	0.2371	0.2375
Pore Pressure	2.9791	2.9794

Date: 1/8/2023

Predrill: 0.00m

Water Level: -

Collapse: 0.60m

Termination

Target Depth

Effective Refusal

- Tip
- Gauge
- Inclinometer
- Other

PointID: CPTu007

Sounding: 1

Operator: E. Diaz Farias

Cone Type: Pagani Piezocone - Compression

Cone Reference: MKS364

Cone Area Ratio: 0.79

Zero load outputs (MPa)	Before test	After test
Tip Resistance	24.2110	24.2527
Local Friction	0.2564	0.2563
Pore Pressure	2.9480	2.9491

Date: 2/8/2023

Predrill: 0.00m

Water Level: -

Collapse: 1.50m

Termination

Target Depth

Effective Refusal

- Tip
- Gauge
- Inclinometer
- Other

PointID: CPTu008

Sounding: 1

Operator: E. Diaz Farias

Cone Type: Pagani Piezocone - Compression

Cone Reference: MKS364

Cone Area Ratio: 0.79

Zero load outputs (MPa)	Before test	After test
Tip Resistance	24.3623	24.3466
Local Friction	0.2557	0.2558
Pore Pressure	2.9490	2.9487

Date: 31/7/2023

Predrill: 0.00m

Water Level: 1.10m

Collapse: 1.80m

Termination

Target Depth

Effective Refusal

- Tip
- Gauge
- Inclinometer
- Other

TEST DETAIL

PointID: CPTu009

Sounding: 1

Operator: E. Diaz Farias

Cone Type: Pagani Piezocone - Compression

Cone Reference: 000328

Cone Area Ratio: 0.79

Zero load outputs (MPa)	Before test	After test
Tip Resistance	28.7312	28.6699
Local Friction	0.2382	0.2389
Pore Pressure	2.9804	2.9790

Date: 31/7/2023

Predrill: 0.00m

Water Level: 0.80m

Collapse: 2.30m

Termination

Target Depth

Effective Refusal

Tip

Gauge

Inclinometer

Other

PointID: CPTu010

Sounding: 1

Operator: E. Diaz Farias

Cone Type: Pagani Piezocone - Compression

Cone Reference: MKS364

Cone Area Ratio: 0.79

Zero load outputs (MPa)	Before test	After test
Tip Resistance	24.1901	24.2892
Local Friction	0.2563	0.2564
Pore Pressure	2.9439	2.9464

Date: 31/7/2023

Predrill: 0.00m

Water Level: -

Collapse: 1.55m

Termination

Target Depth

Effective Refusal

Tip

Gauge

Inclinometer

Other

PointID: CPTu011

Sounding: 1

Operator: E. Diaz Farias

Cone Type: Pagani Piezocone - Compression

Cone Reference: MKS364

Cone Area Ratio: 0.79

Zero load outputs (MPa)	Before test	After test
Tip Resistance	24.2683	24.2892
Local Friction	0.2570	0.2563
Pore Pressure	2.9475	2.9219

Date: 31/7/2023

Predrill: 0.00m

Water Level: 1.10m

Collapse: 1.80m

Termination

Target Depth

Effective Refusal

Tip

Gauge

Inclinometer

Other

PointID: CPTu012

Sounding: 1

Operator: E. Diaz Farias

Cone Type: Pagani Piezocone - Compression

Cone Reference: 000328

Cone Area Ratio: 0.79

Zero load outputs (MPa)	Before test	After test
Tip Resistance	28.6699	28.6954
Local Friction	0.2393	0.2393
Pore Pressure	2.9797	2.9791

Date: 31/7/2023

Predrill: 0.00m

Water Level: 1.10m

Collapse: 1.80m

Termination

Target Depth

Effective Refusal

Tip

Gauge

Inclinometer

Other

PointID: CPTu013

Sounding: 1

Operator: E. Diaz Farias

Cone Type: Pagani Piezocone - Compression

Cone Reference: MKS364

Cone Area Ratio: 0.79

Zero load outputs (MPa)	Before test	After test
Tip Resistance	24.3362	24.3623
Local Friction	0.2562	0.2559
Pore Pressure	2.9491	2.9497

Date: 1/8/2023

Predrill: 0.00m

Water Level: -

Collapse: 1.70m

Termination

Target Depth

Effective Refusal

Tip

Gauge

Inclinometer

Other

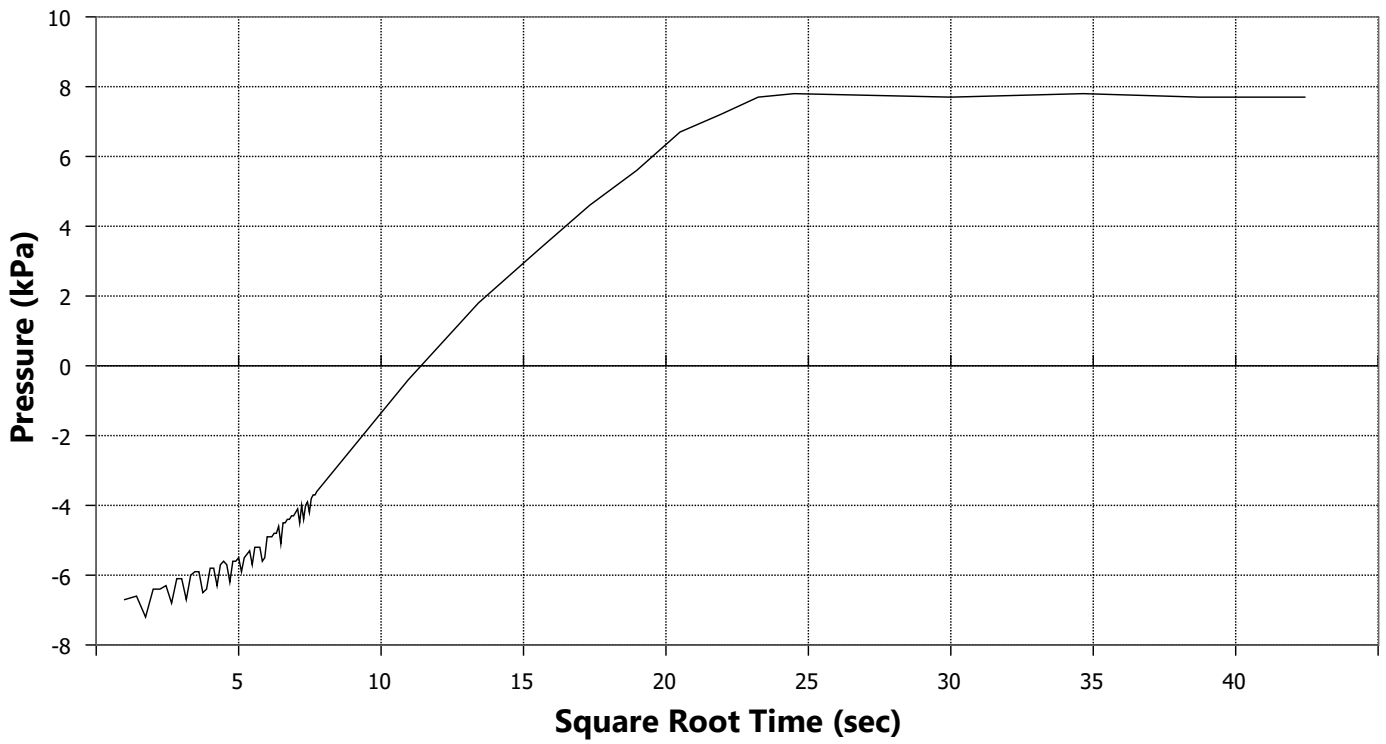
DISSIPATION TESTS

PointID: CPTu002

Test Depth: 2.48

Duration: 1800 seconds

uf: 7.7 kPa (manual pick)



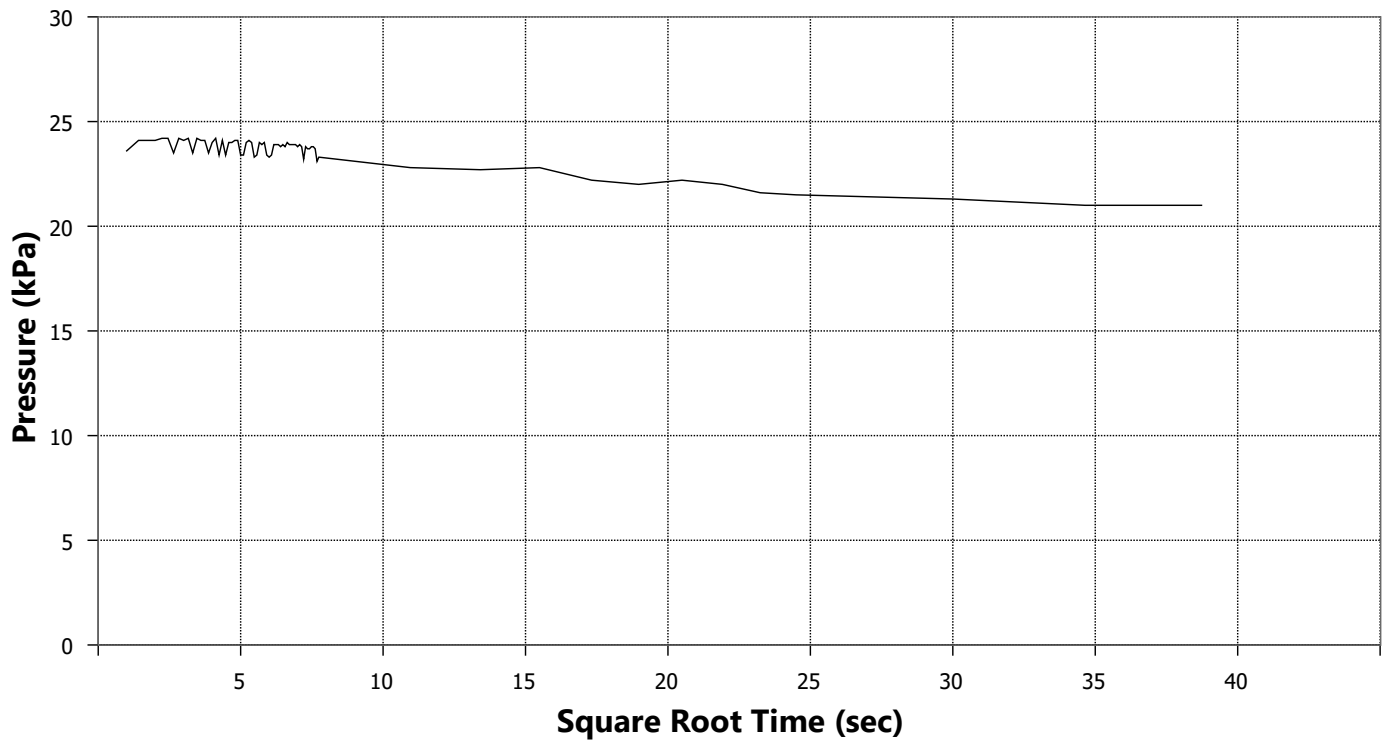
DISSIPATION TESTS

PointID: CPTu004

Test Depth: 4.86

Duration: 1500 seconds

uf: 21.0 kPa (manual pick)



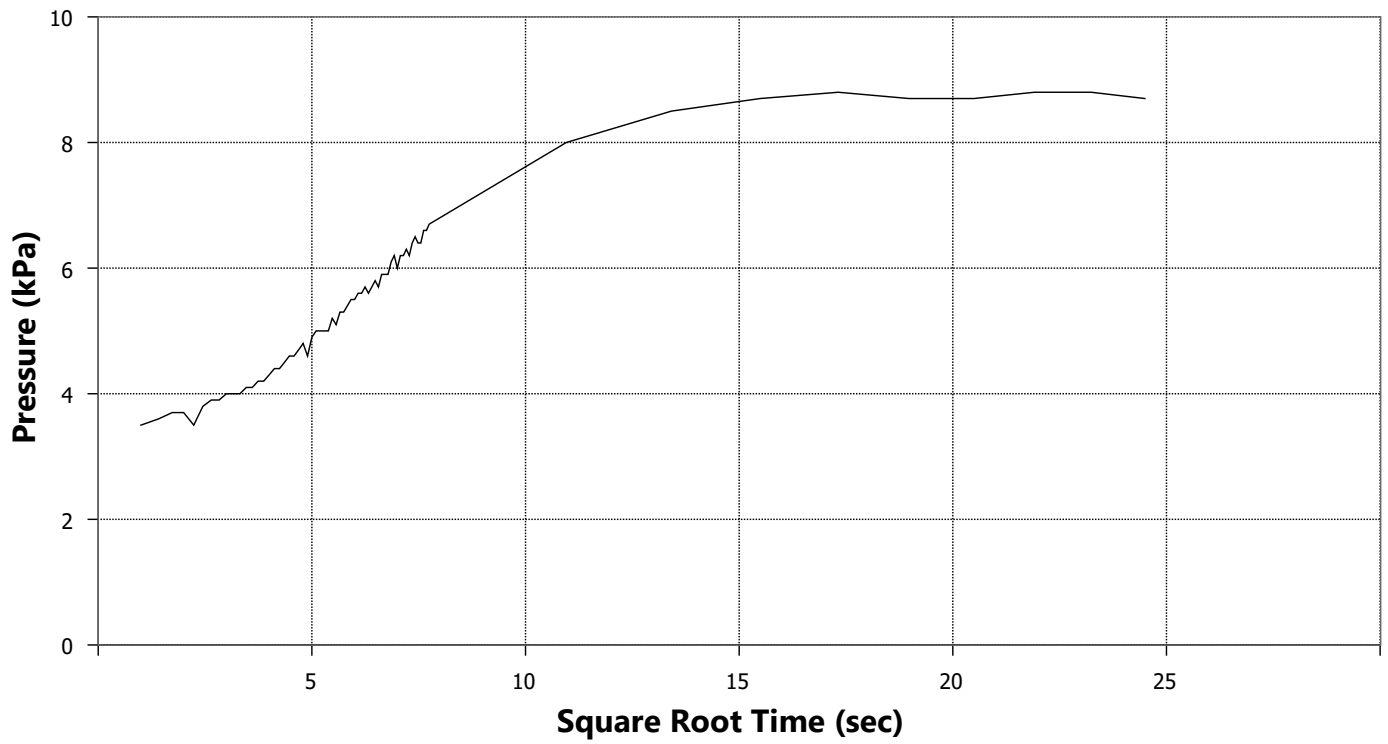
DISSIPATION TESTS

PointID: CPTu005

Test Depth: 2.94

Duration: 600 seconds

uf: 8.7 kPa (manual pick)



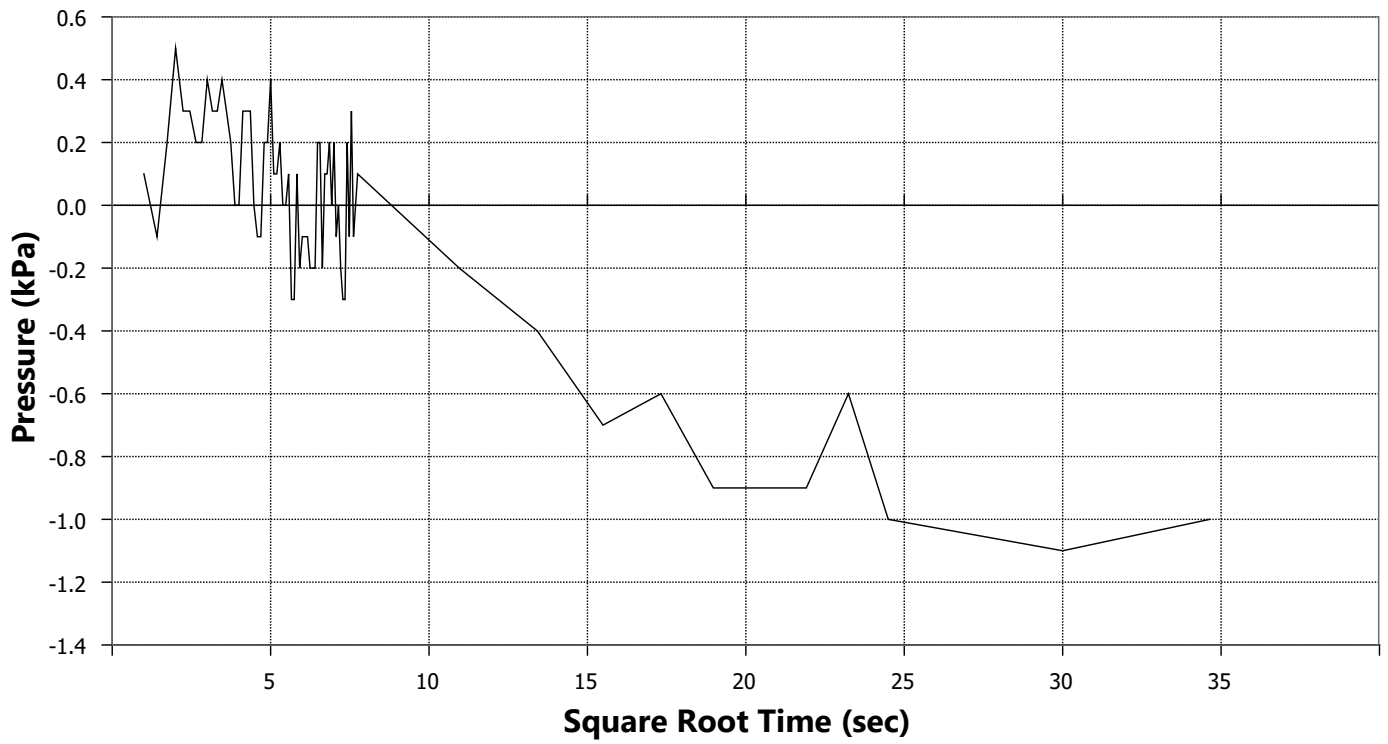
DISSIPATION TESTS

PointID: CPTu006

Test Depth: 1.11

Duration: 1200 seconds

Insufficient pore pressure



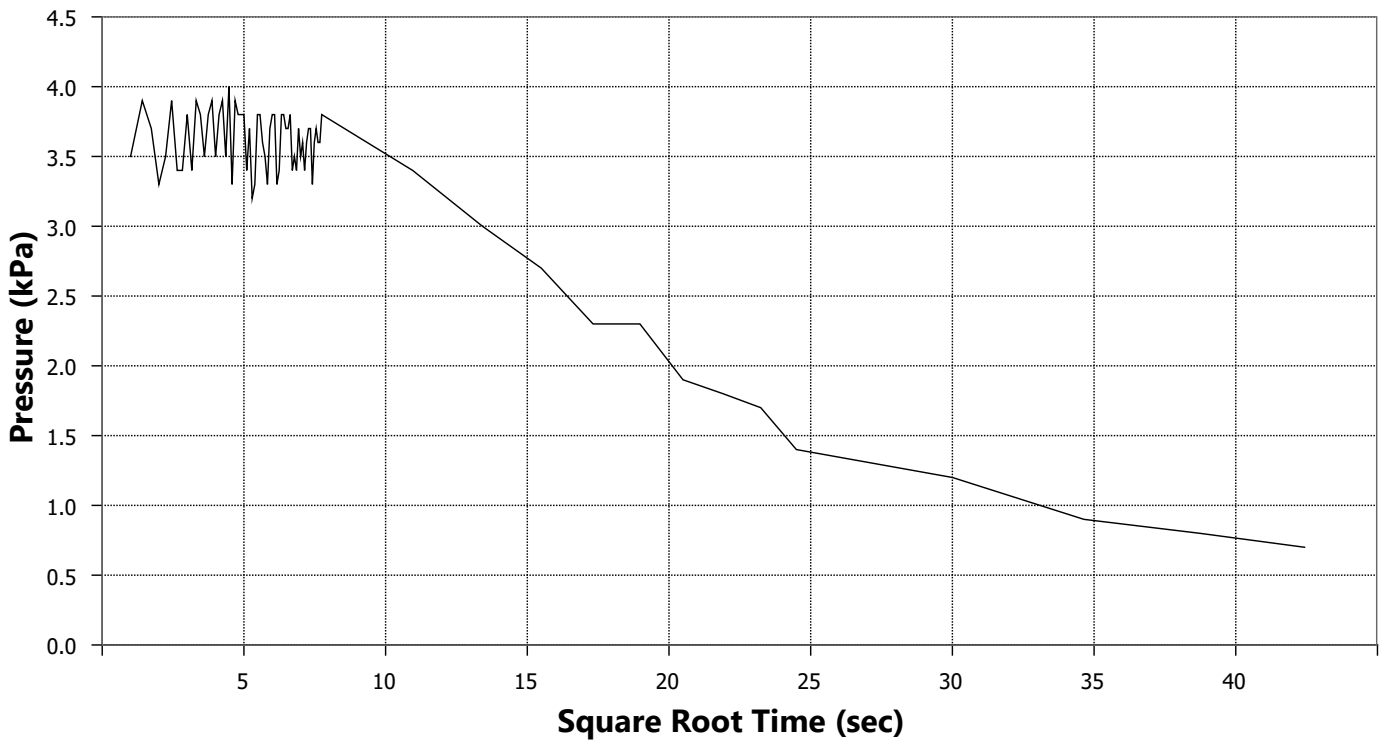
DISSIPATION TESTS

PointID: CPTu007

Test Depth: 1.69

Duration: 1800 seconds

Insufficient pore pressure



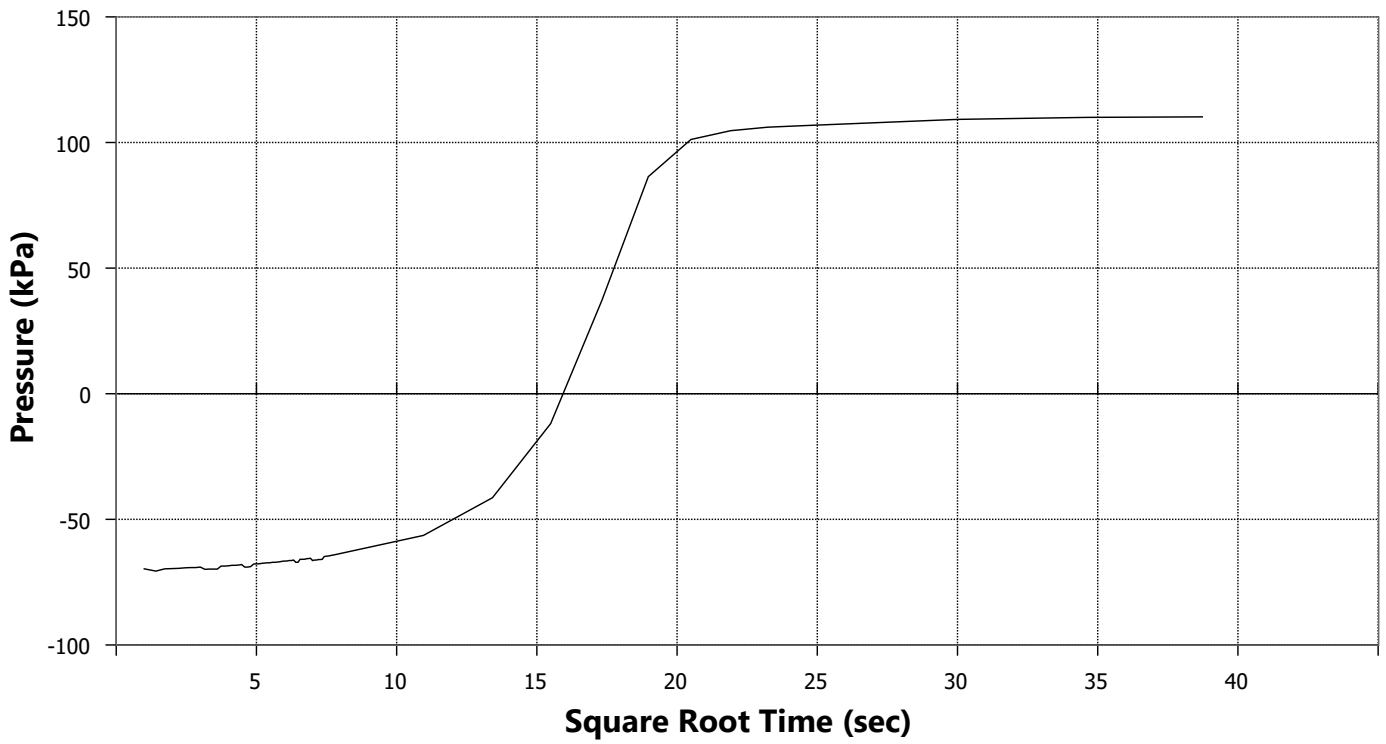
DISSIPATION TESTS

PointID: CPTu009

Test Depth: 12.80

Duration: 1500 seconds

uf: 110.1 kPa (manual pick)



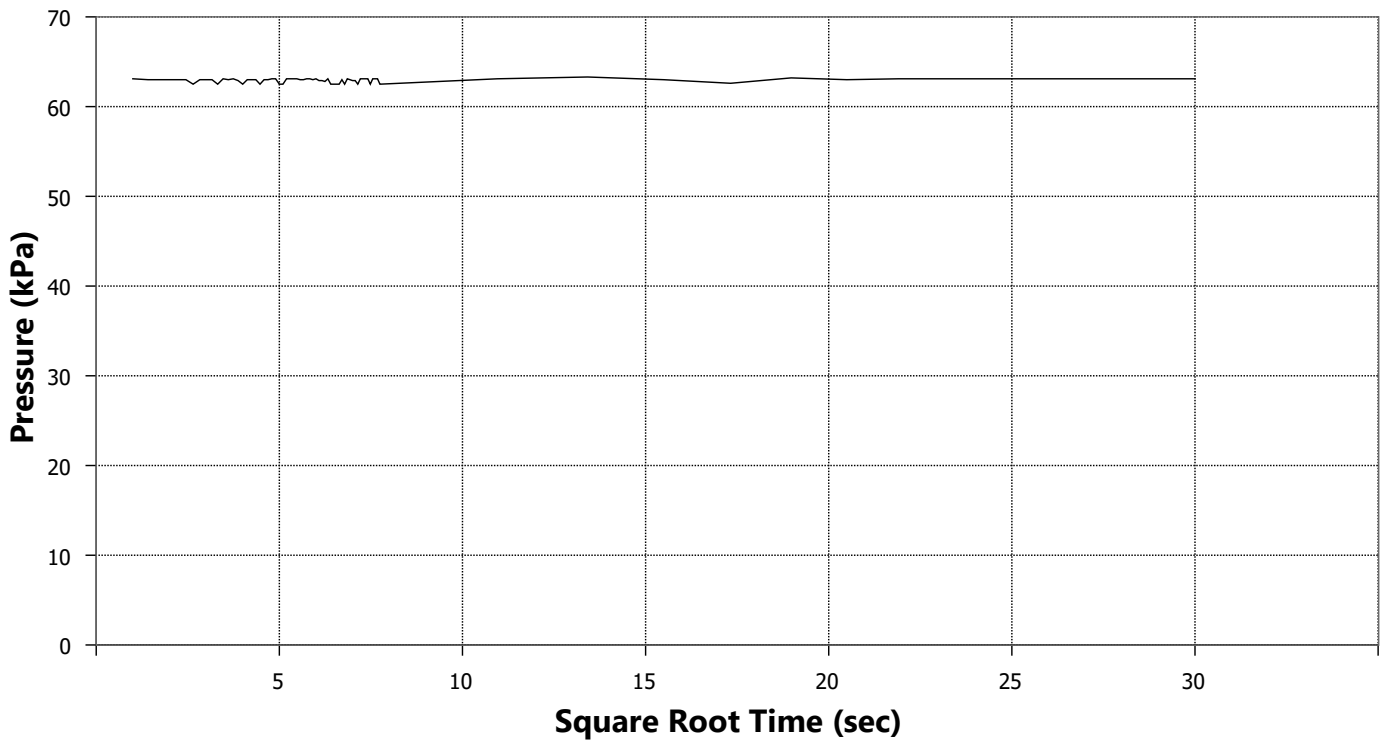
DISSIPATION TESTS

PointID: CPTu010

Test Depth: 7.64

Duration: 900 seconds

uf: 63.1 kPa (manual pick)



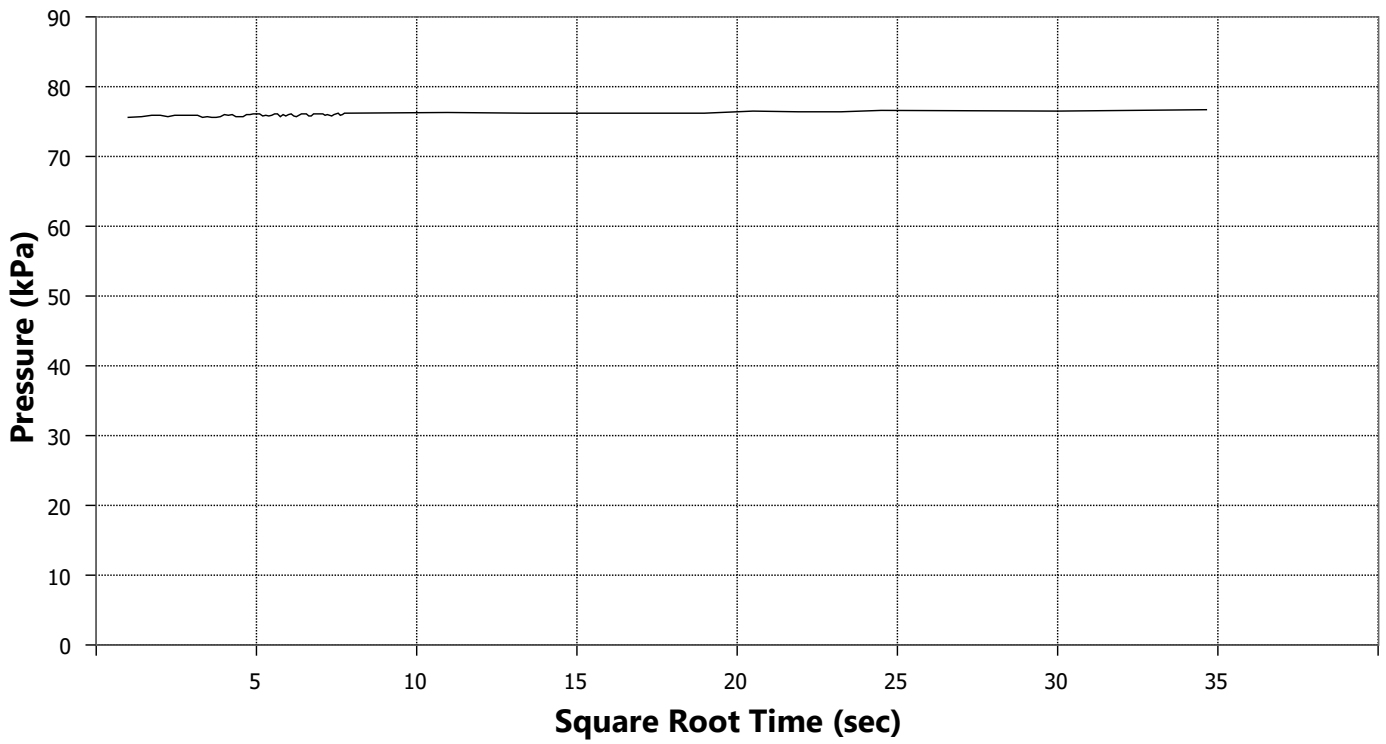
DISSIPATION TESTS

PointID: CPTu011

Test Depth: 9.05

Duration: 1200 seconds

uf: 76.7 kPa (manual pick)



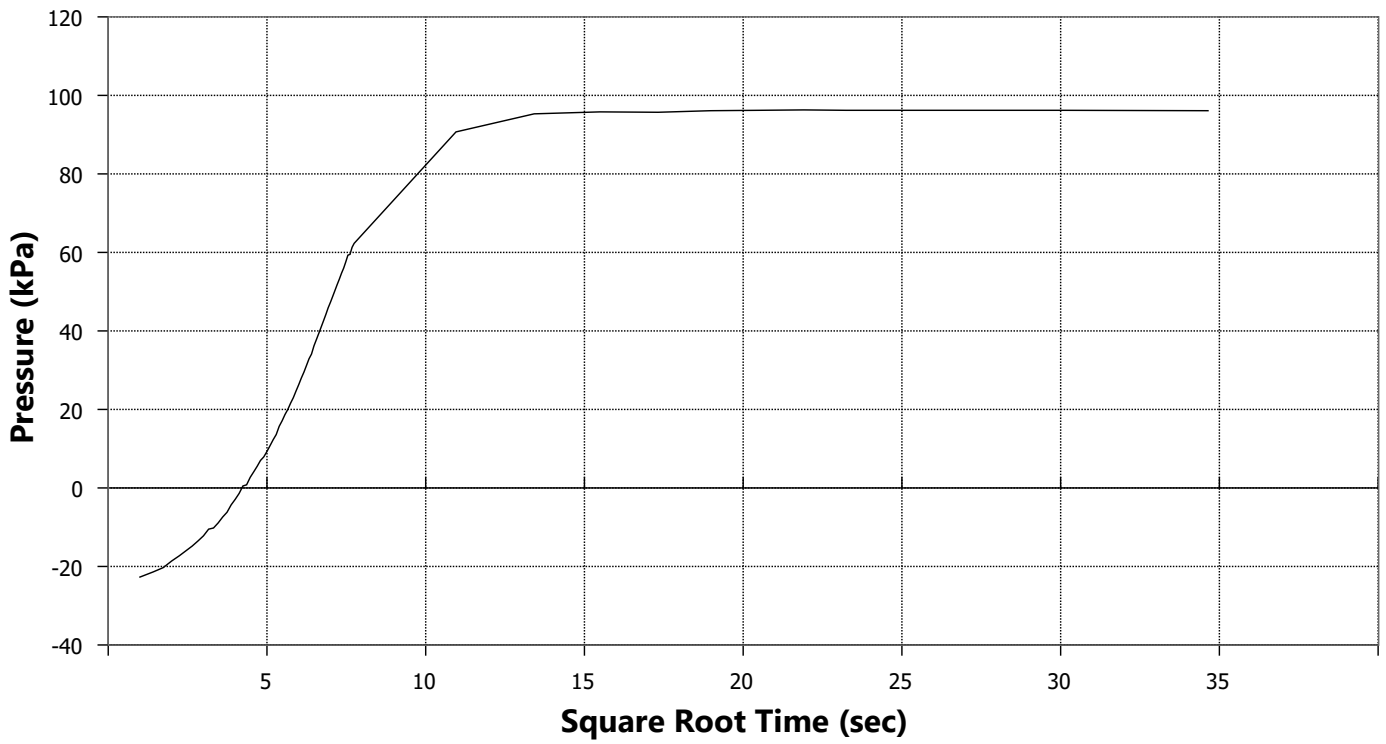
DISSIPATION TESTS

PointID: CPTu012

Test Depth: 10.23

Duration: 1200 seconds

uf: 96.4 kPa (manual pick)



CPT CALIBRATION AND TECHNICAL NOTES

These notes describe the technical specifications and associated calibration references pertaining to the Pagani piezocone types measuring cone resistance, sleeve friction, inclination and pore pressure (piezocone, 10cm²)

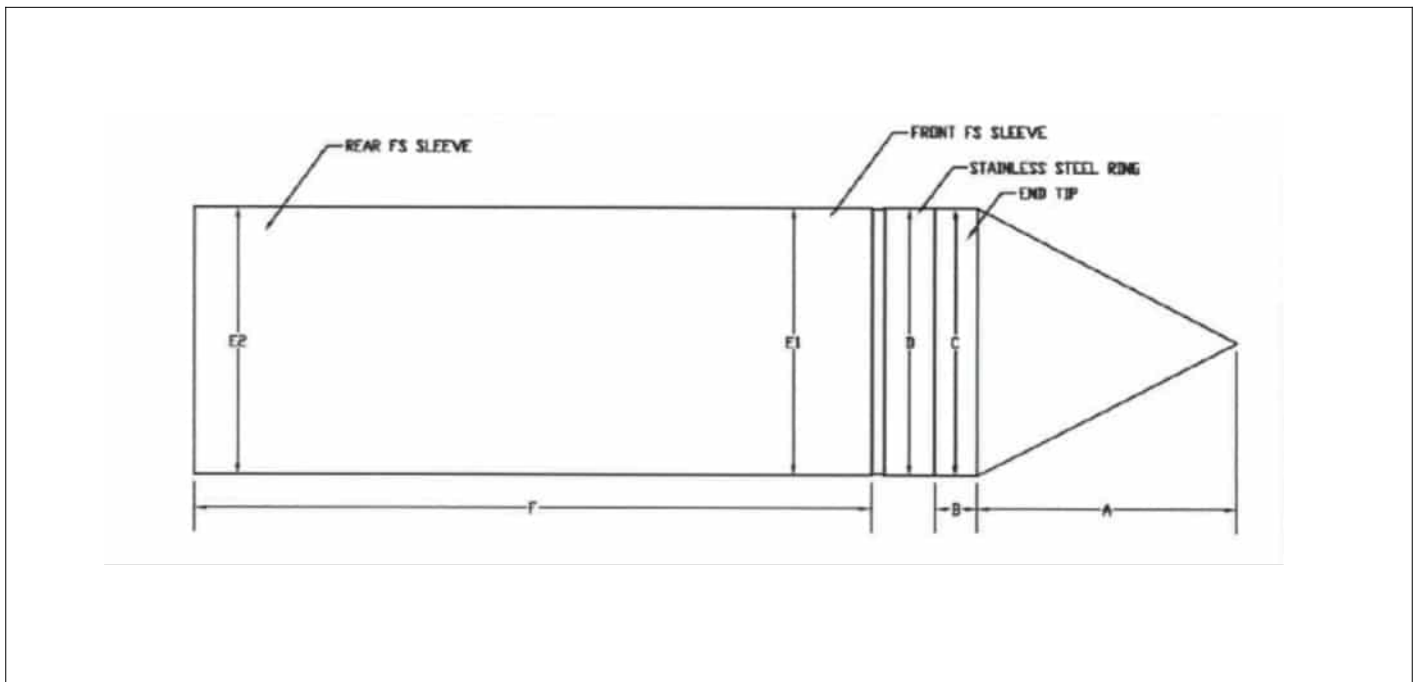
Dimensions

Dimensional specifications are detailed below. All tolerances are routinely checked prior to testing and measurements taken are electronically recorded. All records are kept on file and available on request.

Technical specifications

	Tip	Friction	Pore Pressure	Inclination
Maximum Measuring Range:	50 - 100 MPa	1.60 MPa	2.50 MPa	0° - 20°
Resolution:	24 bit	24 bit	24 bit	12 bit
Accuracy:	0.005 MPa	0.04 MPa	0.04 MPa	0.5°

Length:	320 mm	Weight:	1.8 kg
Diameter:	35.8 mm	Opening angle of bit:	60°
Cone base area:	10 cm ²	Side sleeve surfaces:	150 cm ²
Cone area ratio:	Varies - refer to cone certificate	Tip and Local Friction sensor displacement:	80 mm





CONE CALIBRATION CERTIFICATE
N° 2012/23

Calibrated system (Sistema tarato):

Type **P-C**

Serial number **000328**

Sensor **TIP RESISTANCE**

Max. Capacity [MPa]: **100**

Scaling Factor: **195850**

Tip net area ratio (a_w): **0,79**

Sleeve net ratio (b_w): **0,00**

Addressee (destinatario):
McMillan Drilling Ltd
36 Hickory Place, Islington
Christchurch 8042, New Zealand

Applied load measurement system:
(Sistema di rilevamento del carico applicato)

Load cell:
Manufacturer **AEP transducers**
Model **KAL 200 kN**
Serial Number **138913**

Power press:
Manufacturer **Easydur Italiana**
Model **Aura 20T**
Serial Number **29084**

The measurement system is periodically checked in a SIT calibration center. (Il sistema di rilevamento è sottoposto a verifica periodica presso un centro SIT)

Last verification date: **12/01/2023**

Certificate N. **LAT 091 2023-011**

Temperature of calibration **22°C**

Humidity **45%**

Factory calibration in accordance with:
ASTM D5778-12 Validity 12 Months
ISO 22476-1 (App Class2)



CONE CALIBRATION CERTIFICATE
N° 2012/23

Calibrated system (Sistema tarato):

Type **P-C**

Serial number **000328**

Sensor **SLEEVE FRICTION**

Max. Capacity [kPa]: **1600**

Scaling Factor: **30712**

Addressee (destinatario):
McMillan Drilling Ltd
36 Hickory Place, Islington
Christchurch 8042, New Zealand

Applied load measurement system:
(Sistema di rilevamento del carico applicato)

Load cell:
Manufacturer **AEP transducers**
Model **KAL 50 kN**
Serial Number **65495**

Power press:
Manufacturer **Easydur Italiana**
Model **Aura 10T**
Serial Number **29002**

The measurement system is periodically checked in a SIT calibration center. (Il sistema di rilevamento è sottoposto a verifica periodica presso un centro SIT)

Last verification date: **12/01/2023**

The adopted calibration procedure has been developed according to the suggestions given by
Prof. Paul W. Mayne (Georgia Institute of Technology) and Prof. Diego Lo Presti (University of Pisa)

Cone calibrated by 



CONE CALIBRATION CERTIFICATE
N° 2012/23

Calibrated system (Sistema tarato):

Type **P-C**

Serial number **000328**

Sensor **PORE PRESSURE**

Max. Capacity [kPa]: **2500**

Scaling Factor: **10509**

Sensor **TILT ANGLE**

Max. Inclination [°]: **20**

Scaling Factor: **330350**

Addressee (destinatario):
McMillan Drilling Ltd
36 Hickory Place, Islington
Christchurch 8042, New Zealand

Applied load measurement system:
(Sistema di rilevamento del carico applicato)

Pressure Generator:
Manufacturer **MENSOR**
Model **CPC 4000**
Serial Number **41000V56**
Sensor Descr **Silicon Pressure Transducer**
Sensor Serial Number **41000V3Y**

The measurement system is periodically checked in a SIT calibration center. (Il sistema di rilevamento è sottoposto a verifica periodica presso un centro SIT)

Last verification date: **22/04/2022**

The adopted calibration procedure has been developed according to the suggestions given by
Prof. Paul W. Mayne (Georgia Institute of Technology) and Prof. Diego Lo Presti (University of Pisa)

Date of issue **18/01/2023**

CONE CERTIFICATES



CONE CALIBRATION CERTIFICATE N° Z011/23

Calibrated system (Sistema tarato) :
 Serial number **Mks364**
 Sensor **TIP RESISTANCE**
 Max. Capacity [MPa]: **100**
 Scaling Factor: **191690**
 Tip net area ratio (a_0): **0,79**
 Sleeve net ratio (b_0): **0,00**

Addressee (destinatario) :
 McMillan Drilling Ltd
 36 Hickory Place, Islington
 Christchurch 8042, New Zealand
 Applied load measurement system:
 (Sistema di rilevamento del carico applicato)

Load cell:
 Manufacturer AEP transducers
 Model KAL 200 KN
 Serial Number 138913
 Power press: Easydur Italiana
 Model Aura 20T
 Serial Number 29084

The measurement system is periodically checked in a SIT calibration center. (Il sistema di rilevamento è sottoposto a verifica periodica presso un centro SIT)
 Last verification date: 12/01/2023
 Certificate N. LAT 091 2023-011
 Temperature of calibration 22°C
 Humidity 45%
 Factory calibration in accordance with:
 ASTM D5778-12 Validity 12 Months
 ISO 22476-1 (App Class2)




CONE CALIBRATION CERTIFICATE N° Z011/23

Calibrated system (Sistema tarato) :
 Serial number **Mks364**
 Sensor **SLEEVE FRICTION**
 Max. Capacity [kPa]: **1600**
 Scaling Factor: **30997**

Addressee (destinatario) :
 McMillan Drilling Ltd
 36 Hickory Place, Islington
 Christchurch 8042, New Zealand
 Applied load measurement system:
 (Sistema di rilevamento del carico applicato)

Load cell:
 Manufacturer AEP transducers
 Model KAL 50 KN
 Serial Number 65495
 Power press: Easydur Italiana
 Model Aura 10T
 Serial Number 29002

The measurement system is periodically checked in a SIT calibration center. (Il sistema di rilevamento è sottoposto a verifica periodica presso un centro SIT)
 Last verification date: 12/01/2023
 The adopted calibration procedure has been developed according to the suggestions given by Prof. Paul W. Mayne (Georgia Institute of Technology) and Prof. Diego Lo Presti (University of Pisa)
 Cone calibrated by 



CONE CALIBRATION CERTIFICATE N° Z011/23

Calibrated system (Sistema tarato) :
 Serial number **Mks364**
 Sensor **PORE PRESSURE**
 Max. Capacity [kPa]: **2500**
 Scaling Factor: **10633**
 Sensor **TILT ANGLE**
 Max. Inclination [°]: **20**
 Scaling Factor: **342363**

Addressee (destinatario) :
 McMillan Drilling Ltd
 36 Hickory Place, Islington
 Christchurch 8042, New Zealand
 Applied load measurement system:
 (Sistema di rilevamento del carico applicato)

Pressure Generator:
 Manufacturer MENSOR
 Model CPC 4000
 Serial Number 41000V56
 Sensor Deser Silicon Pressure Transducer
 Sensor Serial Number 41000V3Y

The measurement system is periodically checked in a SIT calibration center. (Il sistema di rilevamento è sottoposto a verifica periodica presso un centro SIT)
 Last verification date: 22/04/2022
 Date of issue 18/01/2023

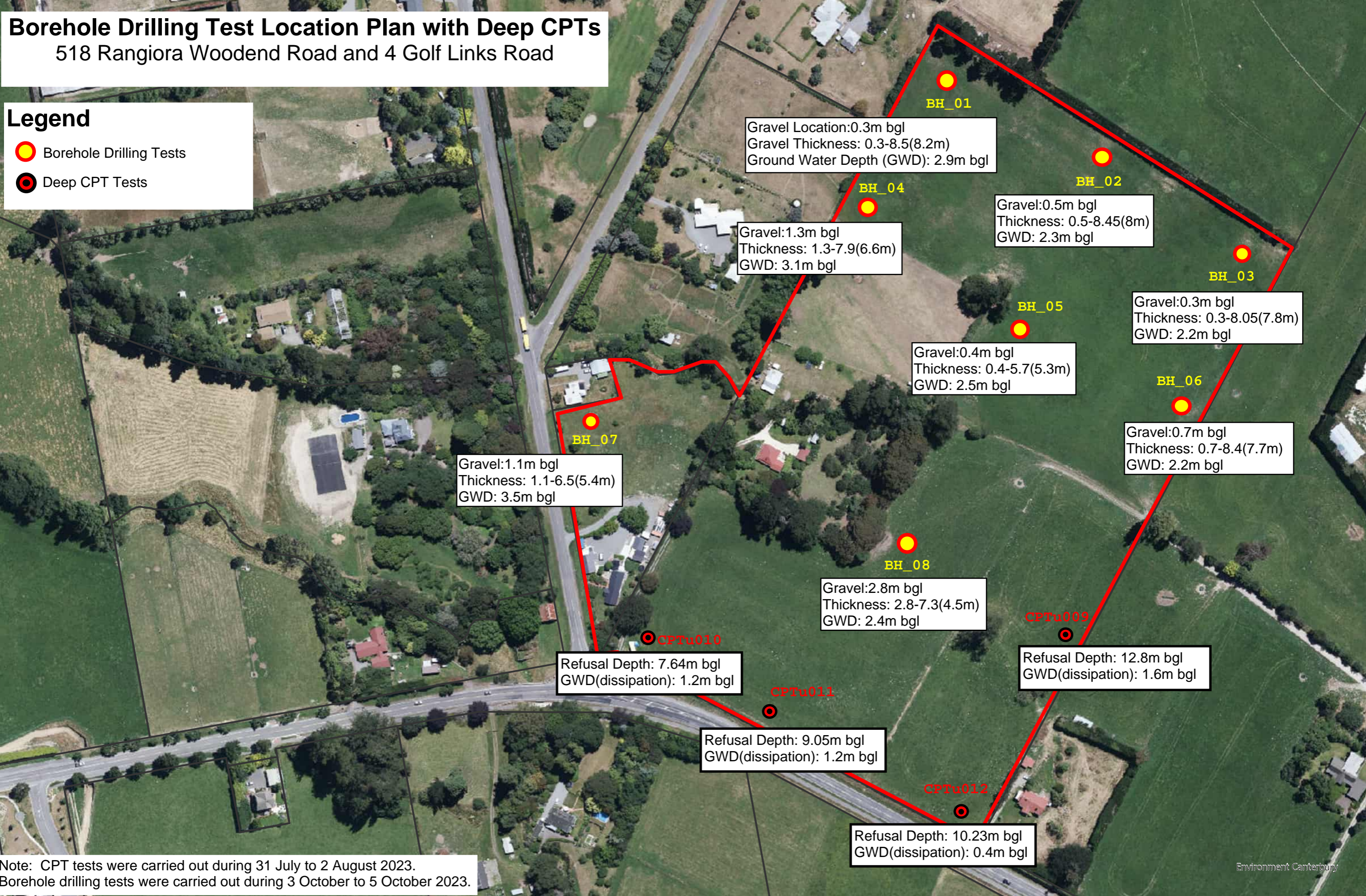
Appendix C. Pro-drill Borehole Drilling Testing Records

Borehole Drilling Test Location Plan with Deep CPTs

518 Rangiora Woodend Road and 4 Golf Links Road

Legend

- Borehole Drilling Tests
- Deep CPT Tests



Note: CPT tests were carried out during 31 July to 2 August 2023.
 Borehole drilling tests were carried out during 3 October to 5 October 2023.

PRO-DRILL

SPECIALIST DRILLING ENGINEERS

OCTOBER 06, 2023

DRILLING REPORT PREPARED FOR

ELIOT SINCLAIR

#JOB-2144 - 518 Rangiora Woodend Rd and 4 Golf Links Road

518 Rangiora Woodend Road

Pro-Drill (Auck) Ltd

11 Alpito Place, Pukekohe, Auckland, New Zealand

www.prodrill.co.nz

0800 477 637

 **BORE HOLE REPORT**

HOLE NAME	BH-01	DATE	04.10.2023
LOCATION	E 1569113 N 5206109 518 Rangiora Woodend Road	JOB #	JOB-2144
CUSTOMER	Eliot Sinclair Maggie Guo,64 20 4185 3681 MG@eliot Sinclair.co.nz	RIG ID	FRASTE CRS XLI (HE: 81.5%)

DRILL LOGS

0.0m	1442 hrs	FRASTE CRS XLI (HE: 81.5%)
0.0m	1442 hrs	Sonic
10.6m	1608 hrs	Sonic casing type 10.6m casing depth




 **SPT TEST**

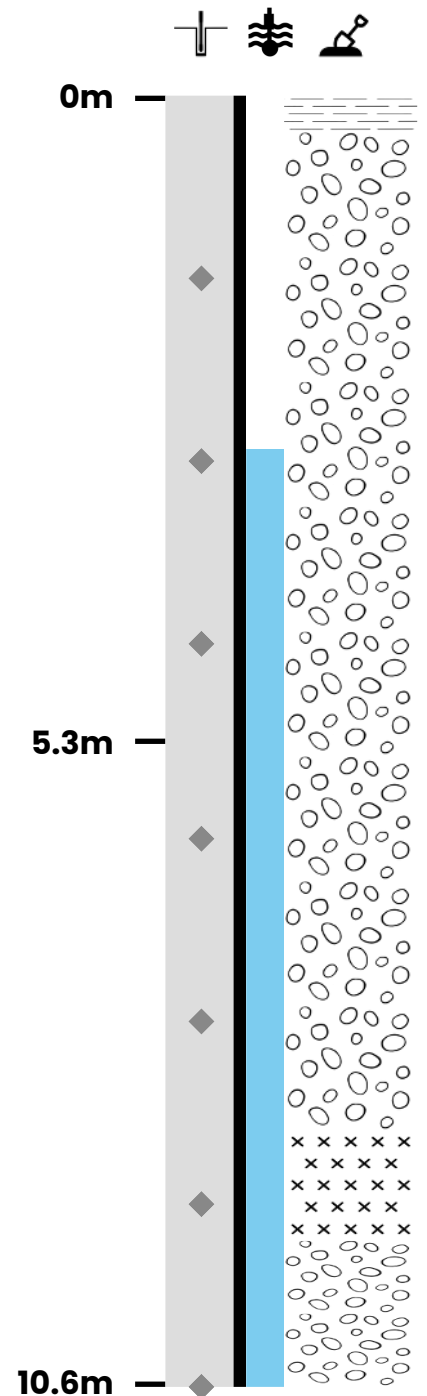
1.5m	4/5/6/6/8/9	N=29
3.0m	4/7/8/7/8/6	N=29
4.5m	4/4/3/3/2/5	N=13
6.1m	7/10/11/12/11/9	N=43
7.6m	5/4/6/5/6/5	N=22
9.1m	2/3/3/3/5/5	N=16
10.6m	7/7/10/8/7/6	N=31

 **WATER + INSTALLS**

2.9m	Water level
-------------	-------------

 **SOIL LAYERS**

0.0m	 Clay
0.3m	 Gravel
8.5m	 Silt



9.4m



Gravel



 **BORE HOLE REPORT**

HOLE NAME	BH-02	DATE	04.10.2023
LOCATION	E 1569203 N 5206052 518 Rangiora Woodend Road	JOB #	JOB-2144
CUSTOMER	Eliot Sinclair Maggie Guo,64 20 4185 3681 MG@eliot Sinclair.co.nz	RIG ID	FRASTE CRS XLI (HE: 81.5%)

DRILL LOGS

0.0m	1123 hrs	FRASTE CRS XLI (HE: 81.5%)
0.0m	1123 hrs	Sonic
10.6m	1426 hrs	Sonic casing type 10.6m casing depth




 **SPT TEST**

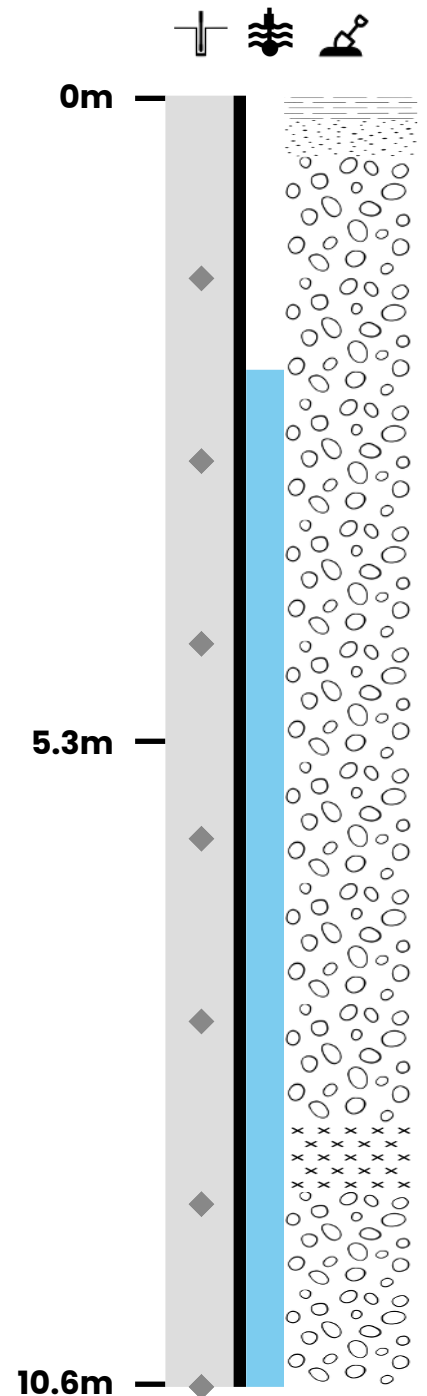
1.5m	5/6/8/8/7/7	N=30
3.0m	5/6/5/3/5/5	N=18
4.5m	17/12/10/7/5/5	N=27
6.1m	2/2/2/2/3/3	N=10
7.6m	4/3/3/3/5/5	N=16
9.1m	7/7/8/9/8/7	N=32
10.6m	7/11/8/8/8/12	N=36

 **WATER + INSTALLS**

2.3m	Water level
-------------	-------------

 **SOIL LAYERS**

0.0m	 Clay
0.2m	 Sand
0.5m	 Gravel



8.4m



Silt

9.0m



Gravel



 **BORE HOLE REPORT**

HOLE NAME	BH-03	DATE	04.10.2023
LOCATION	E 1569312 N 5205985 518 Rangiora Woodend Road	JOB #	JOB-2144
CUSTOMER	Eliot Sinclair Maggie Guo,64 20 4185 3681 MG@eliot Sinclair.co.nz	RIG ID	FRASTE CRS XLI (HE: 81.5%)

DRILL LOGS

0.0m	0854 hrs	FRASTE CRS XLI (HE: 81.5%)
0.0m	0854 hrs	Sonic
10.6m	1047 hrs	Sonic casing type 10.6m casing depth




 **SPT TEST**

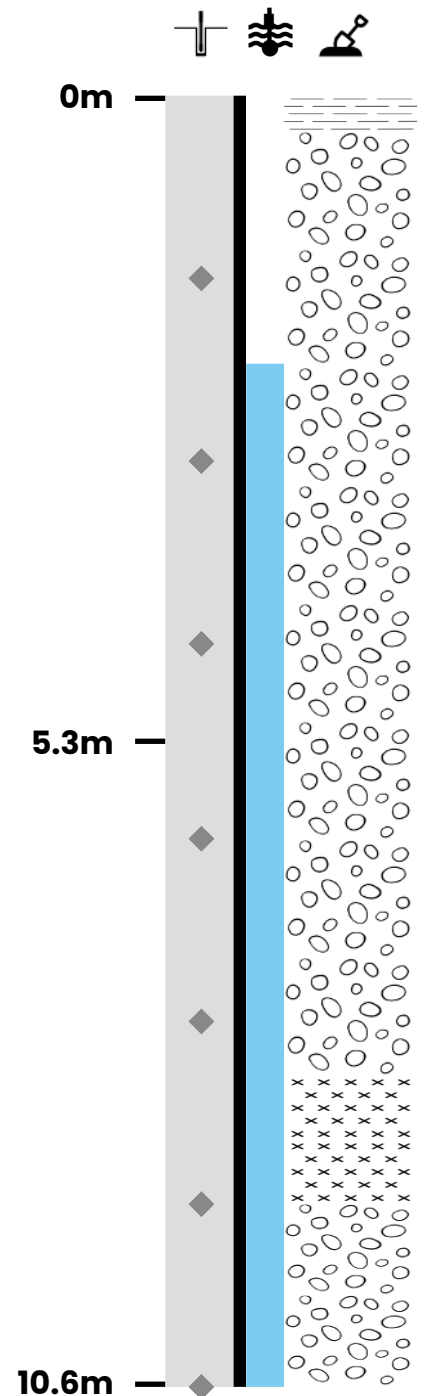
1.5m	6/5/5/6/7/6	N=24
3.0m	6/7/7/9/8/8	N=32
4.5m	6/6/5/5/5/6	N=21
6.1m	5/5/6/6/7/7	N=26
7.6m	5/7/6/3/2/1	N=12
9.1m	9/8/12/16/16/6	N=50 For 45mm
10.6m	4/7/9/10/10/10	N=39

 **WATER + INSTALLS**

2.2m	Water level
-------------	-------------

 **SOIL LAYERS**

0.0m	 Clay
0.3m	 Gravel
8.1m	 Silt







 **BORE HOLE REPORT**

HOLE NAME	BH-04	DATE	05.10.2023
LOCATION	E 1569062 N 5206004 518 Rangiora Woodend Road	JOB #	JOB-2144
CUSTOMER	Eliot Sinclair Maggie Guo,64 20 4185 3681 MG@eliot Sinclair.co.nz	RIG ID	FRASTE CRS XLI (HE: 81.5%)

DRILL LOGS

0.0m	0740 hrs	FRASTE CRS XLI (HE: 81.5%)
0.0m	0740 hrs	Sonic





 **SPT TEST**

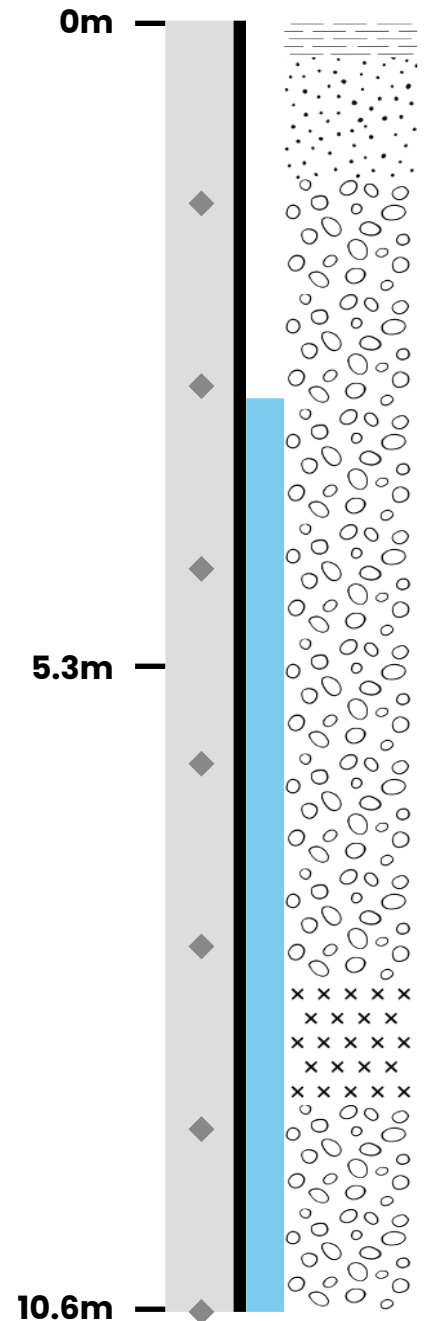
1.5m	4/4/4/4/2/4	N=14
3.0m	3/7/8/7/6/6	N=27
4.5m	3/5/5/6/5/5	N=21
6.1m	3/3/5/5/5/6	N=21
7.6m	9/5/4/3/1/1	N=9
9.1m	9/9/10/11/9/10	N=40
10.6m	7/9/9/11/10/12	N=42

 **WATER + INSTALLS**

3.1m	Water level
-------------	-------------

 **SOIL LAYERS**

0.0m	 Clay
0.3m	 Sand
1.3m	 Gravel
7.9m	 Silt



8.9m



Gravel

 **BORE HOLE REPORT**

HOLE NAME	BH-05	DATE	05.10.2023
LOCATION	E 1569157 N 5205943 518 Rangiora Woodend Road	JOB #	JOB-2144
CUSTOMER	Eliot Sinclair Maggie Guo,64 20 4185 3681 MG@eliot Sinclair.co.nz	RIG ID	FRASTE CRS XLI (HE: 81.5%)

DRILL LOGS

0.0m	1034 hrs	FRASTE CRS XLI (HE: 81.5%)
0.0m	1034 hrs	Sonic
10.6m	1258 hrs	Sonic casing type 10.6m casing depth




 **SPT TEST**

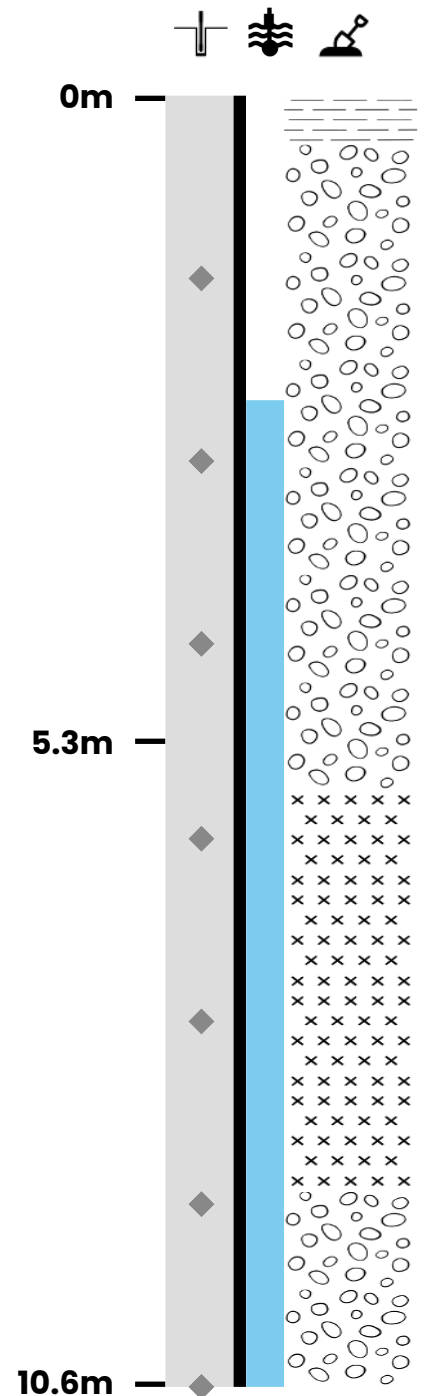
1.5m	6/6/5/5/7/7	N=24
3.0m	3/9/9/8/6/11	N=34
4.5m	9/8/5/12/10/6	N=33
6.1m	1/1/2/2/3/4	N=11
7.6m	1/4/3	N=8
9.1m	3/4/7/8/8/10	N=33
10.6m	7/12/11/16/17/6	N=50 For 25mm

 **WATER + INSTALLS**

2.5m	Water level
-------------	-------------

 **SOIL LAYERS**

0.0m	 Clay
0.4m	 Gravel
5.7m	 Silt



9.0m



Gravel



 **BORE HOLE REPORT**

HOLE NAME	BH-06	DATE	03.10.2023
LOCATION	E 1569266 N 5205883 518 Rangiora Woodend Road	JOB #	JOB-2144
CUSTOMER	Eliot Sinclair Maggie Guo,64 20 4185 3681 MG@eliot Sinclair.co.nz	RIG ID	FRASTE CRS XLI (HE: 81.5%)

DRILL LOGS

0.0m	1144 hrs	FRASTE CRS XLI (HE: 81.5%)
0.0m	1144 hrs	Sonic
10.6m	1519 hrs	Sonic casing type 10.6m casing depth




 **SPT TEST**

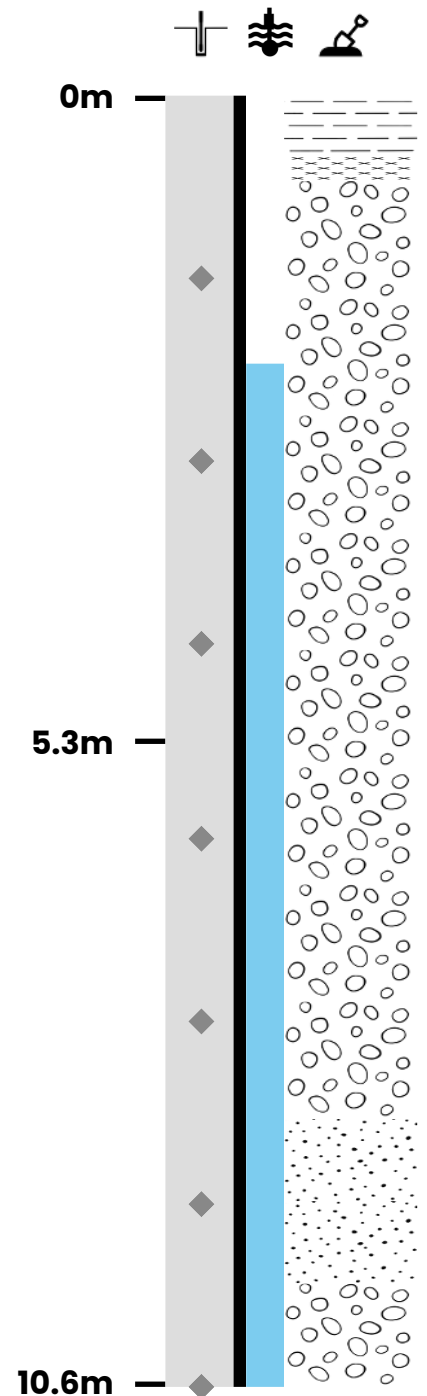
1.5m	5/7/6/7/6/8	N=27
3.0m	8/8/11/9/6/5	N=31
4.5m	4/11/9/9/7/10	N=35
6.1m	3/3/3/4/3/2	N=12
7.6m	4/5/8/5/7/7	N=27
9.1m	2/2/3/2/4/4	N=13
10.6m	7/8/9/9/7/8	N=33

 **WATER + INSTALLS**

2.2m	Water level
-------------	-------------

 **SOIL LAYERS**

0.0m	 Clay
0.5m	 Silt
0.7m	 Gravel



8.4m



Sand

9.8m



Gravel



 **BORE HOLE REPORT**

HOLE NAME	BH-07	DATE	05.10.2023
LOCATION	E 1568902 N 5205871 518 Rangiora Woodend Road	JOB #	JOB-2144
CUSTOMER	Eliot Sinclair Maggie Guo,64 20 4185 3681 MG@eliot Sinclair.co.nz	RIG ID	FRASTE CRS XLI (HE: 81.5%)

DRILL LOGS

0.0m	1357 hrs	FRASTE CRS XLI (HE: 81.5%)
0.0m	1357 hrs	Sonic





 **SPT TEST**

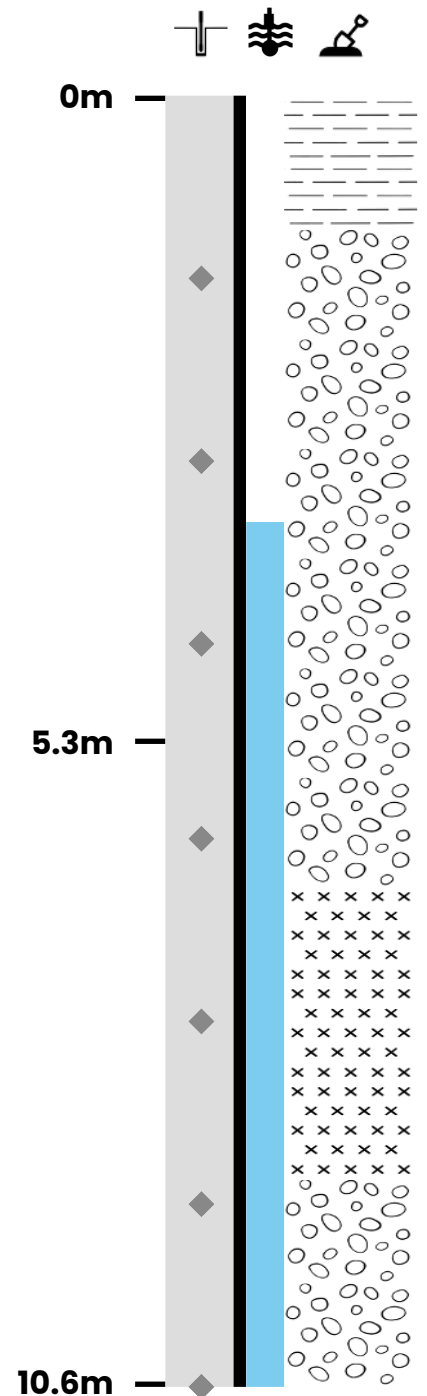
1.5m	6/6/11/9/12/13	N=45
3.0m	4/5/4/5/3/3	N=15
4.5m	4/4/5/4/5/5	N=19
6.1m	4/5/4/3/2/3	N=12
7.6m	1/3/3	N=7
9.1m	5/5/7/5/6/10	N=28
10.6m	9/9/9/9/10/9	N=37

 **WATER + INSTALLS**

3.5m	Water level
-------------	-------------

 **SOIL LAYERS**

0.0m	 Clay
1.1m	 Gravel
6.5m	 Silt
8.9m	 Gravel



 **BORE HOLE REPORT**

HOLE NAME	BH-08	DATE	03.10.2023
LOCATION	E 1569077 N 5205794 518 Rangiora Woodend Road	JOB #	JOB-2144
CUSTOMER	Eliot Sinclair Maggie Guo,64 20 4185 3681 MG@eliot Sinclair.co.nz	RIG ID	FRASTE CRS XLI (HE: 81.5%)

DRILL LOGS

0.0m	0904 hrs	FRASTE CRS XLI (HE: 81.5%)
0.0m	0904 hrs	Sonic
10.6m	1117 hrs	Sonic casing type 10.6m casing depth




 **SPT TEST**

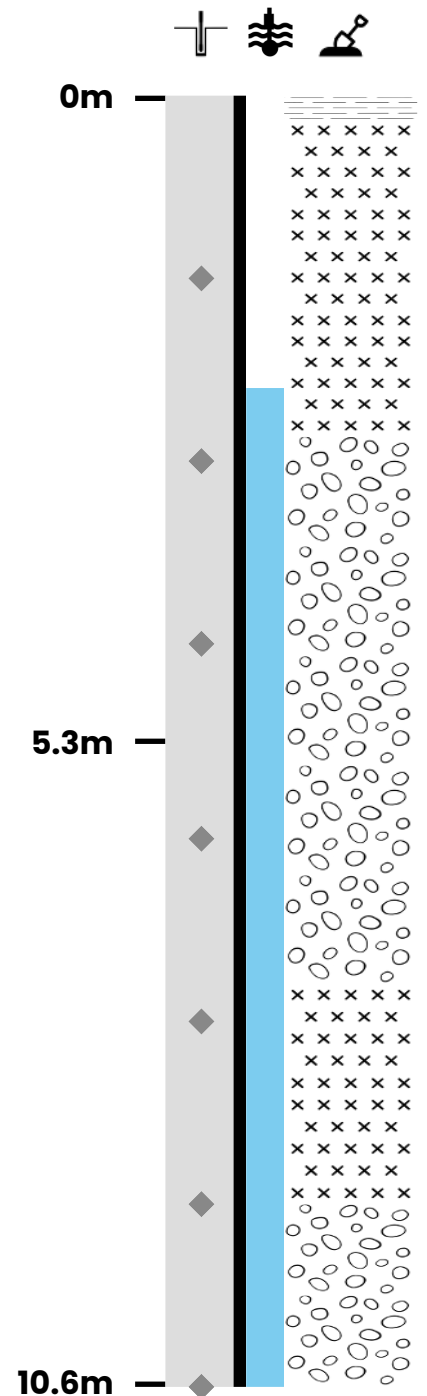
1.5m	1/1/1	N=3
3.0m	4/4/5/5/4/5	N=19
4.5m	3/2/4/4/2/3	N=13
6.1m	6/7/8/8/7/8	N=31
7.6m	2/1/1/1/1/2	N=5
9.1m	11/10/12/11/11/13	N=47
10.6m	9/11/10/11/11/9	N=41

 **WATER + INSTALLS**

2.4m	Water level
-------------	-------------

 **SOIL LAYERS**

0.0m	 Clay
0.2m	 Silt
2.8m	 Gravel



7.3m



Silt

9.1m



Gravel



PRO-DRILL

0800 477 637

www.prodrill.co.nz

11 Alpito Place, Pukekohe, Auckland, New Zealand

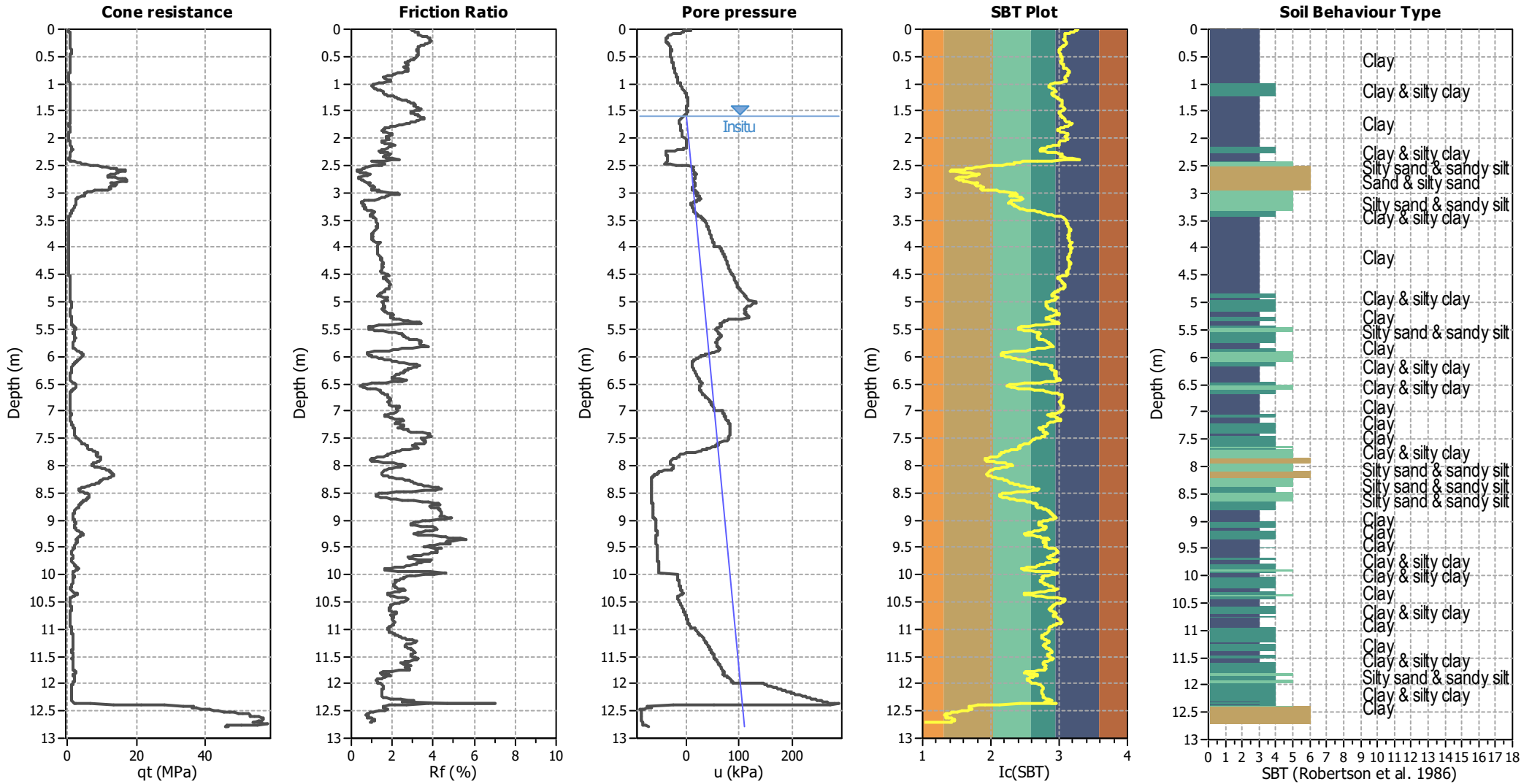
This report was prepared in line with the New Zealand Ground Investigation Specification. Interpretation should be by a suitably qualified specialist.

 **Magnetize**

This report was created in Magnetize™, using the LIVE GEO™ Powerup
www.magnetize.co.nz

Appendix D. CPT Based-Liquefaction Analysis Report

CPT basic interpretation plots



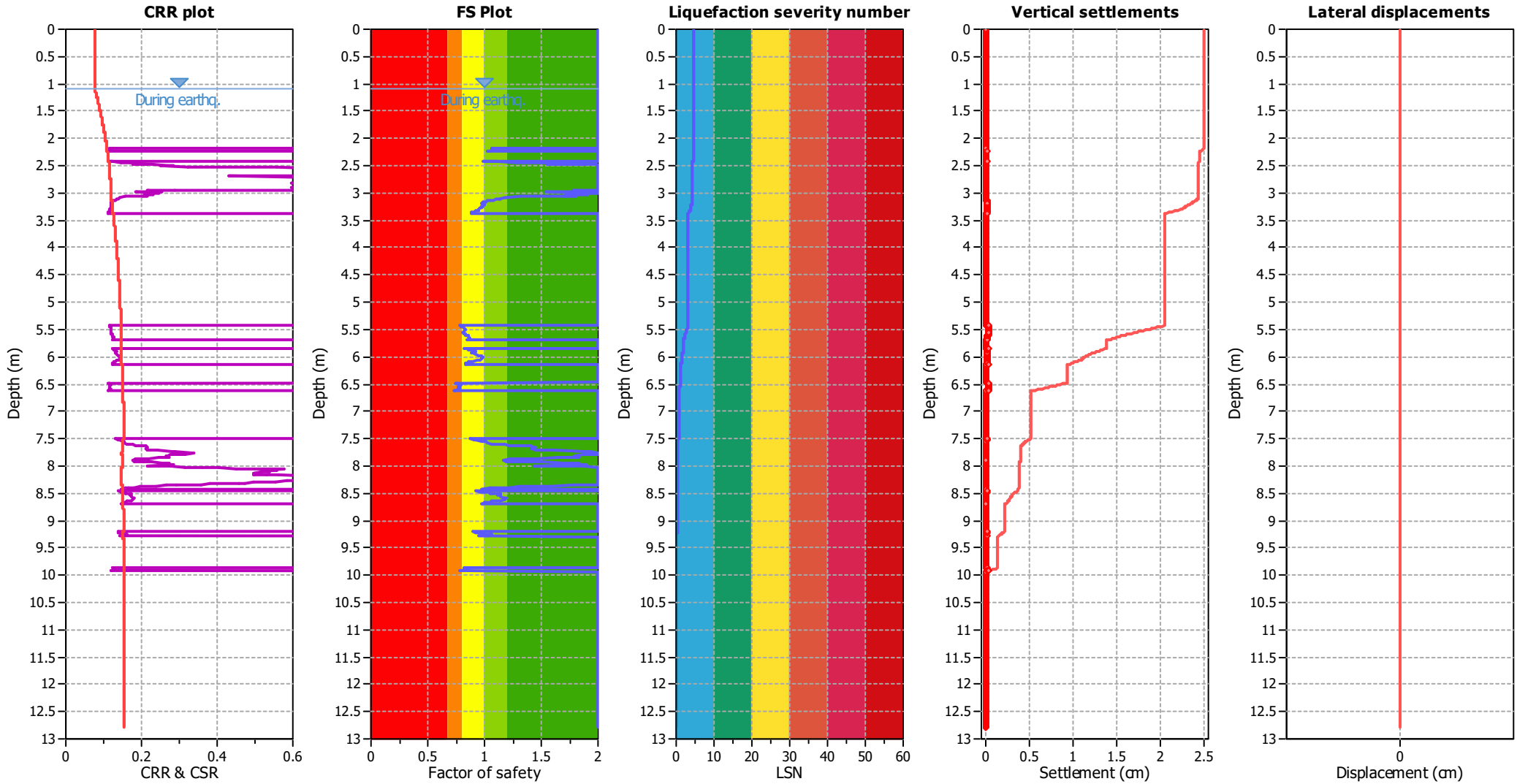
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.10 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_v applied:	Yes
Earthquake magnitude M_w :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.13	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.60 m	Fill height:	N/A	Limit depth:	10.00 m

SBT legend

■ 1. Sensitive fine grained	■ 4. Clayey silt to silty	■ 7. Gravely sand to sand
■ 2. Organic material	■ 5. Silty sand to sandy silt	■ 8. Very stiff sand to
■ 3. Clay to silty clay	■ 6. Clean sand to silty sand	■ 9. Very stiff fine grained

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.10 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_v applied:	Yes
Earthquake magnitude M_w :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.13	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.60 m	Fill height:	N/A	Limit depth:	10.00 m

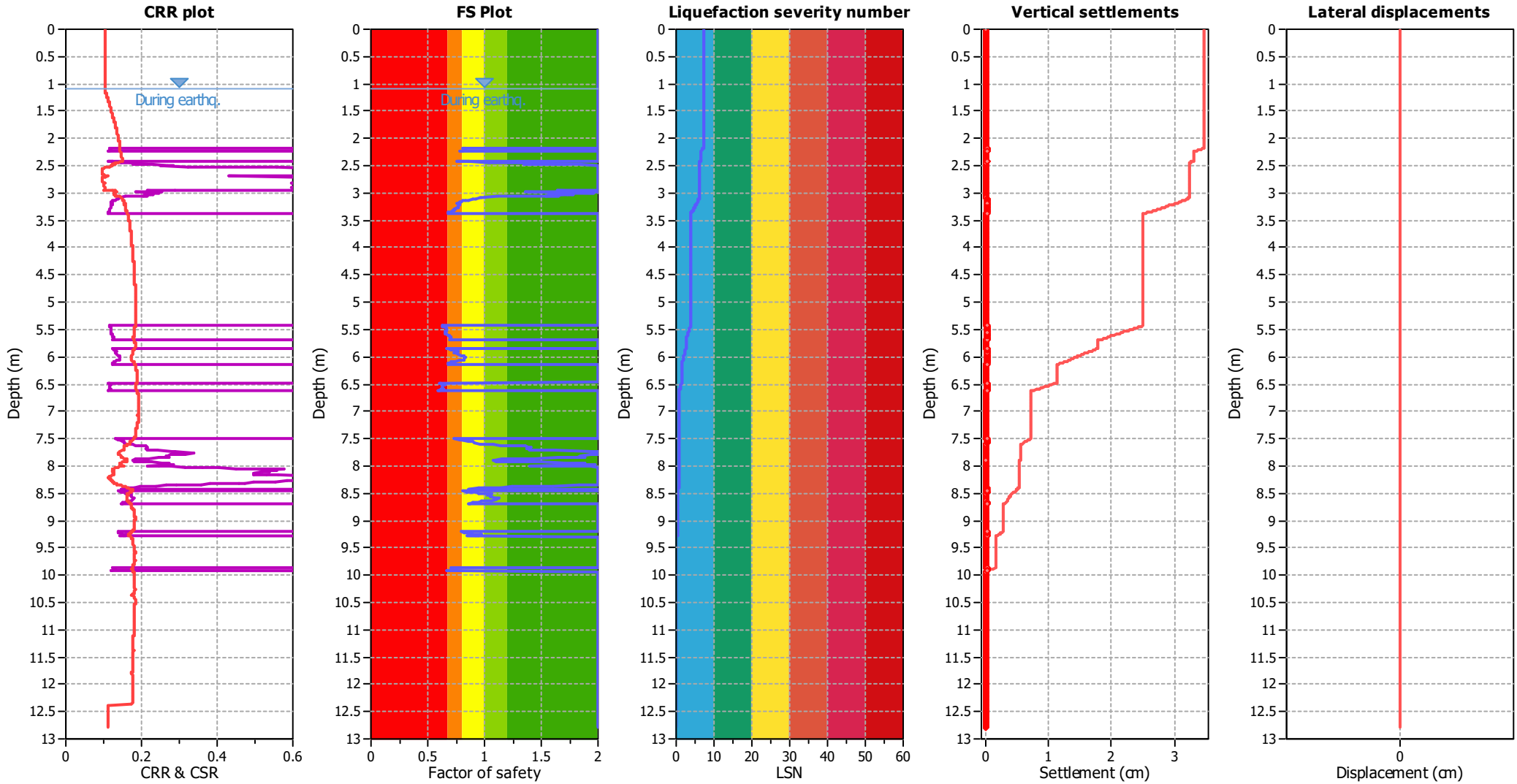
F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LSN color scheme

- Severe damage
- Major expression of liquefaction
- Moderate to severe exp. of liquefaction
- Moderate expression of liquefaction
- Minor expression of liquefaction
- Little to no expression of liquefaction

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.10 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_v applied:	Yes
Earthquake magnitude M_w :	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.60 m	Fill height:	N/A	Limit depth:	10.00 m

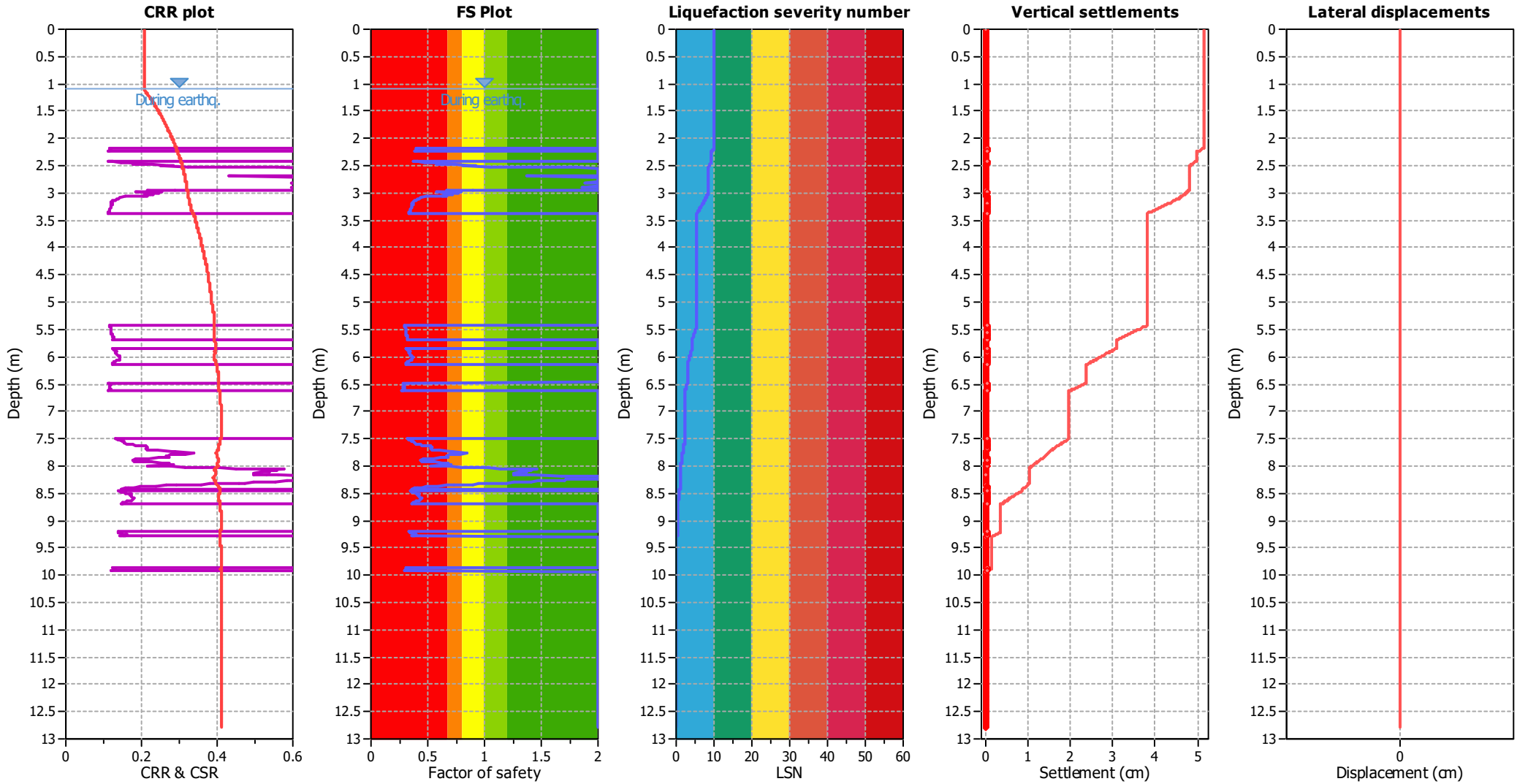
F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LSN color scheme

- Severe damage
- Major expression of liquefaction
- Moderate to severe exp. of liquefaction
- Moderate expression of liquefaction
- Minor expression of liquefaction
- Little to no expression of liquefaction

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.10 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_v applied:	Yes
Earthquake magnitude M_w :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.60 m	Fill height:	N/A	Limit depth:	10.00 m

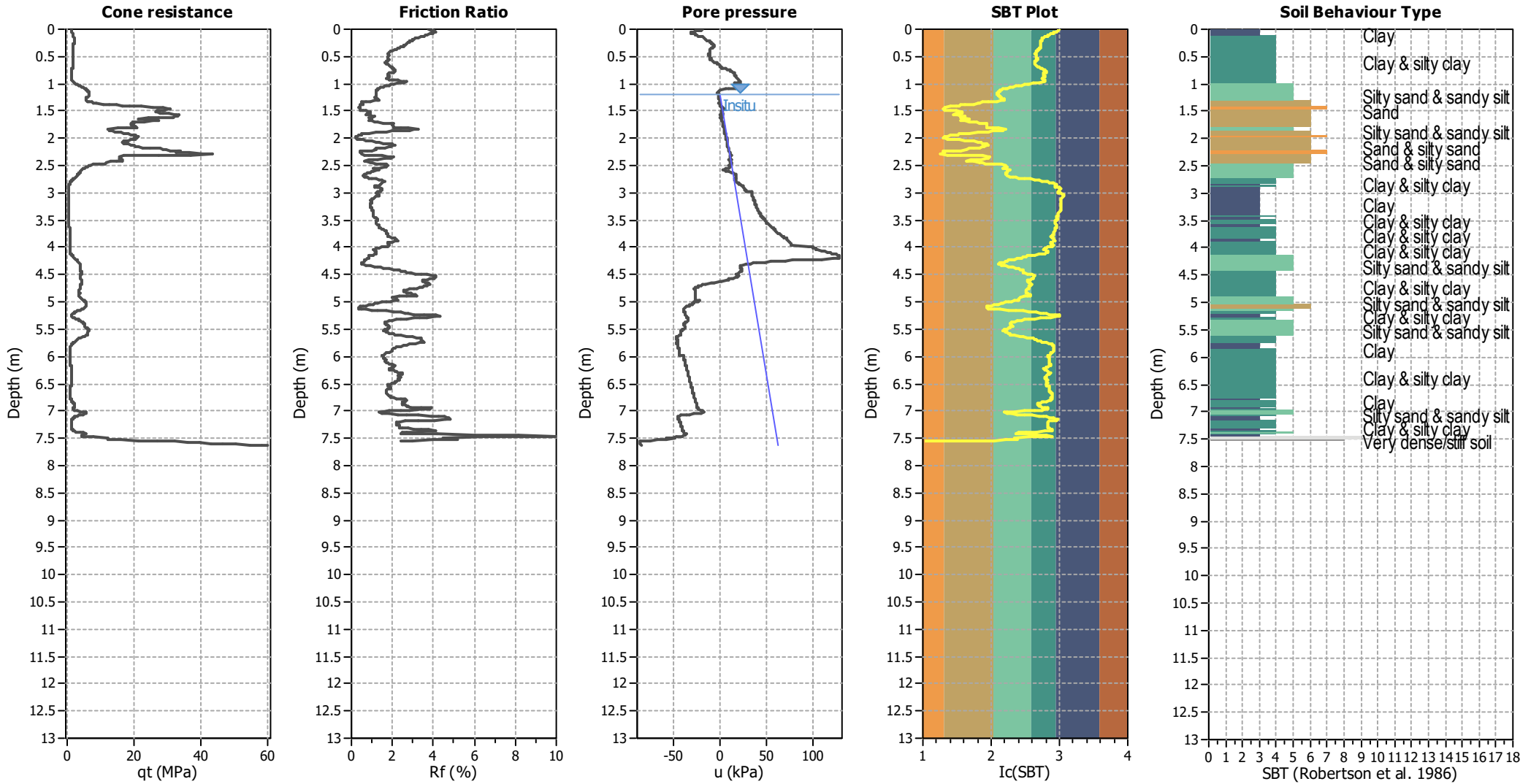
F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LSN color scheme

- Severe damage
- Major expression of liquefaction
- Moderate to severe exp. of liquefaction
- Moderate expression of liquefaction
- Minor expression of liquefaction
- Little to no expression of liquefaction

CPT basic interpretation plots



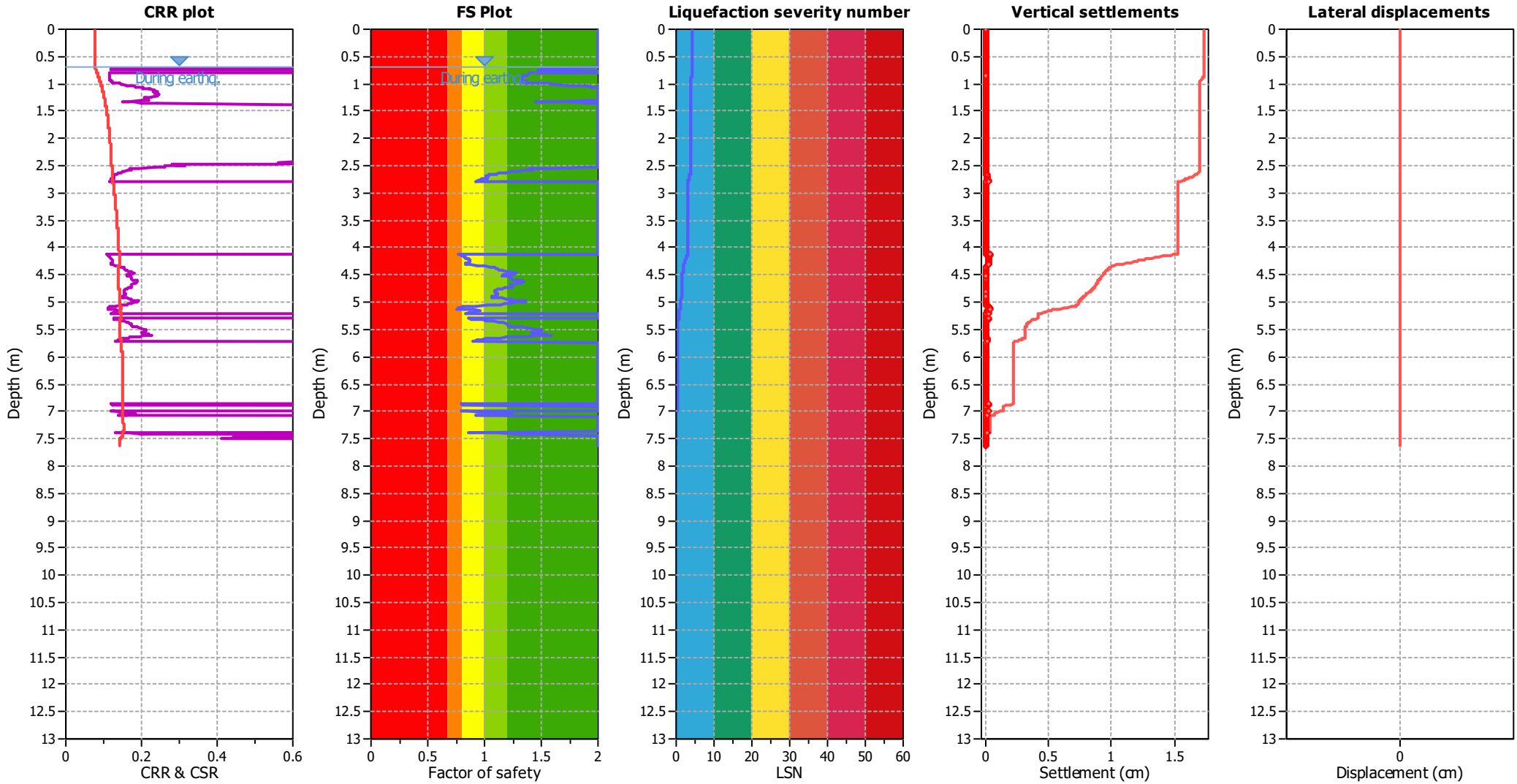
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.70 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_v applied:	Yes
Earthquake magnitude M_w :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.13	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.20 m	Fill height:	N/A	Limit depth:	10.00 m

SBT legend

■ 1. Sensitive fine grained	■ 4. Clayey silt to silty	■ 7. Gravely sand to sand
■ 2. Organic material	■ 5. Silty sand to sandy silt	■ 8. Very stiff sand to
■ 3. Clay to silty clay	■ 6. Clean sand to silty sand	■ 9. Very stiff fine grained

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.70 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_v applied:	Yes
Earthquake magnitude M_w :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.13	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.20 m	Fill height:	N/A	Limit depth:	10.00 m

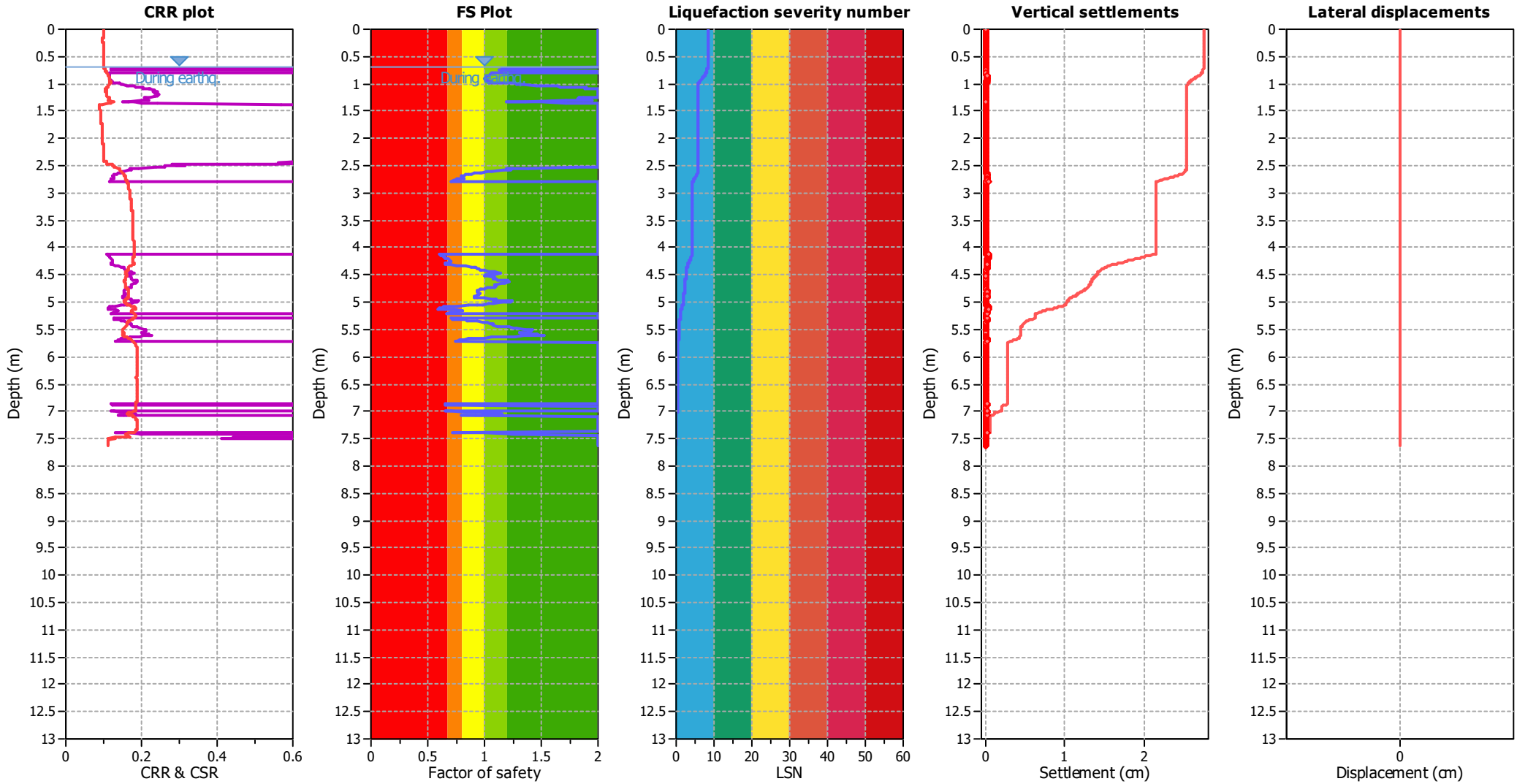
F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LSN color scheme

- Severe damage
- Major expression of liquefaction
- Moderate to severe exp. of liquefaction
- Moderate expression of liquefaction
- Minor expression of liquefaction
- Little to no expression of liquefaction

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.70 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_v applied:	Yes
Earthquake magnitude M_w :	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.20 m	Fill height:	N/A	Limit depth:	10.00 m

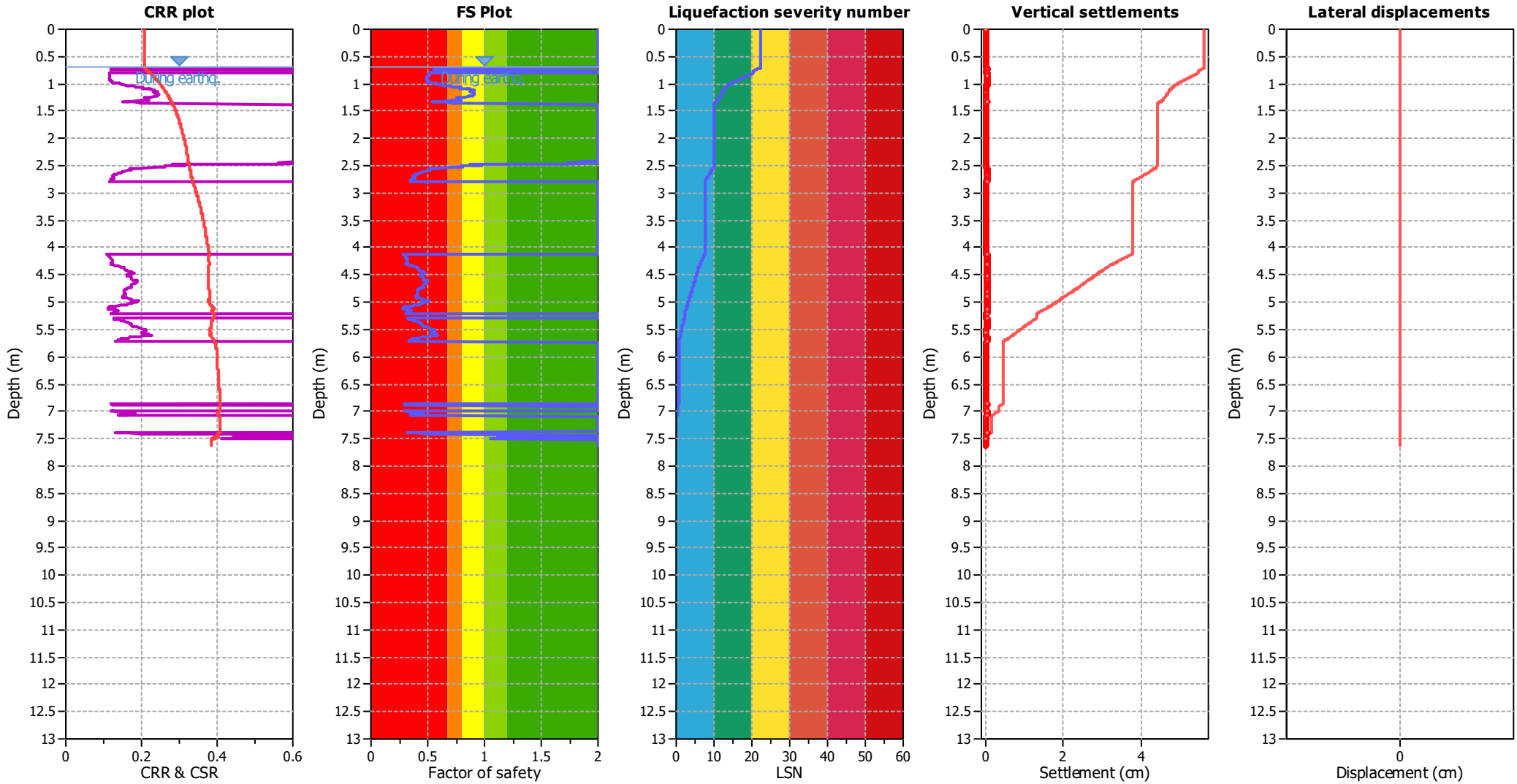
F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LSN color scheme

- Severe damage
- Major expression of liquefaction
- Moderate to severe exp. of liquefaction
- Moderate expression of liquefaction
- Minor expression of liquefaction
- Little to no expression of liquefaction

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.70 m
Fines correction method:	B&I (2014)	Average results interval:	3
Points to test:	Based on Ic value	Ic cut-off value:	2.60
Earthquake magnitude M_w :	7.50	Unit weight calculation:	Based on SBT
Peak ground acceleration:	0.35	Use fill:	No
Depth to water table (insitu):	1.20 m	Fill height:	N/A

Fill weight:	N/A
Transition detect. applied:	No
K_v applied:	Yes
Clay like behavior applied:	Sands only
Limit depth applied:	Yes
Limit depth:	10.00 m

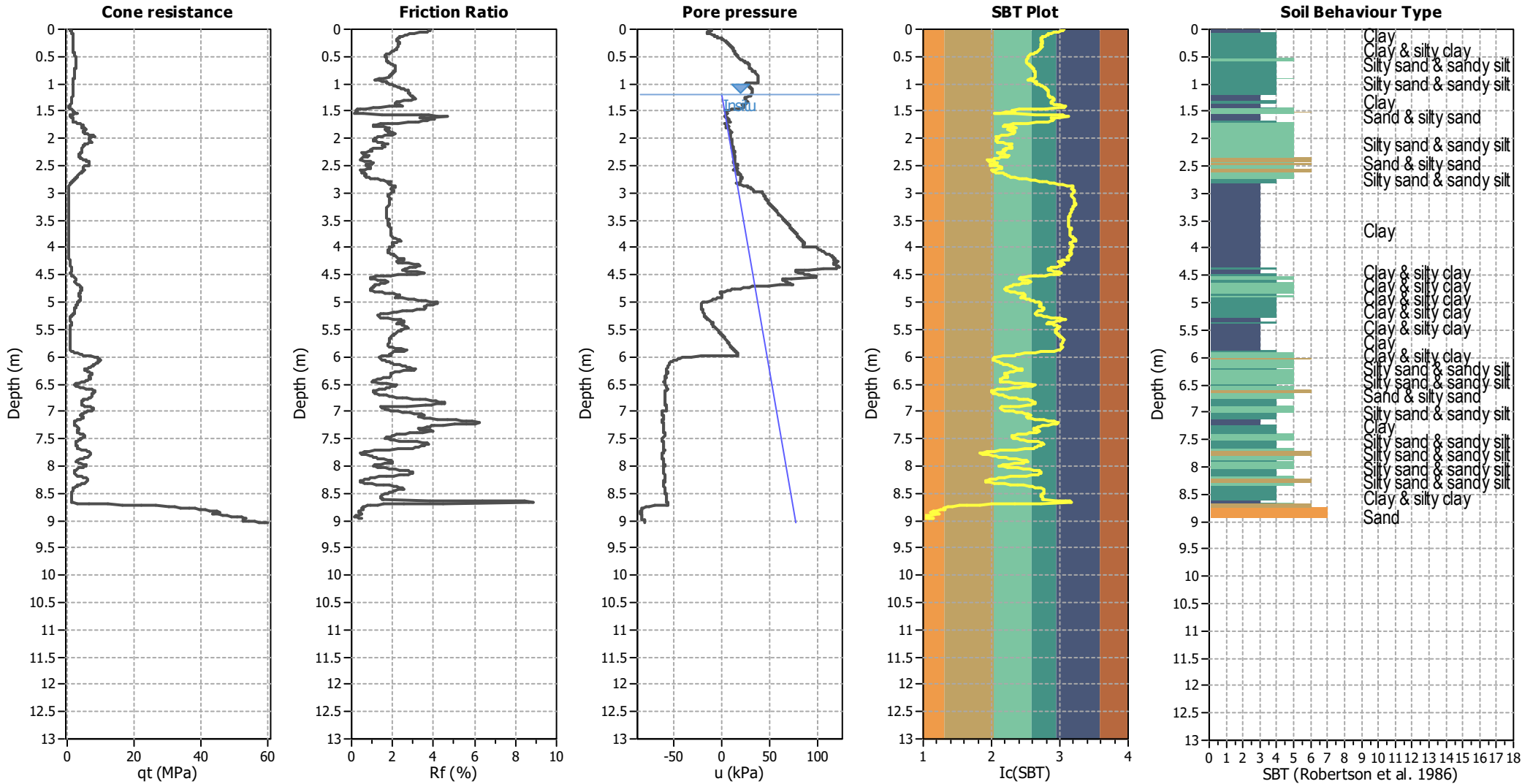
F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LSN color scheme

- Severe damage
- Major expression of liquefaction
- Moderate to severe exp. of liquefaction
- Moderate expression of liquefaction
- Minor expression of liquefaction
- Little to no expression of liquefaction

CPT basic interpretation plots



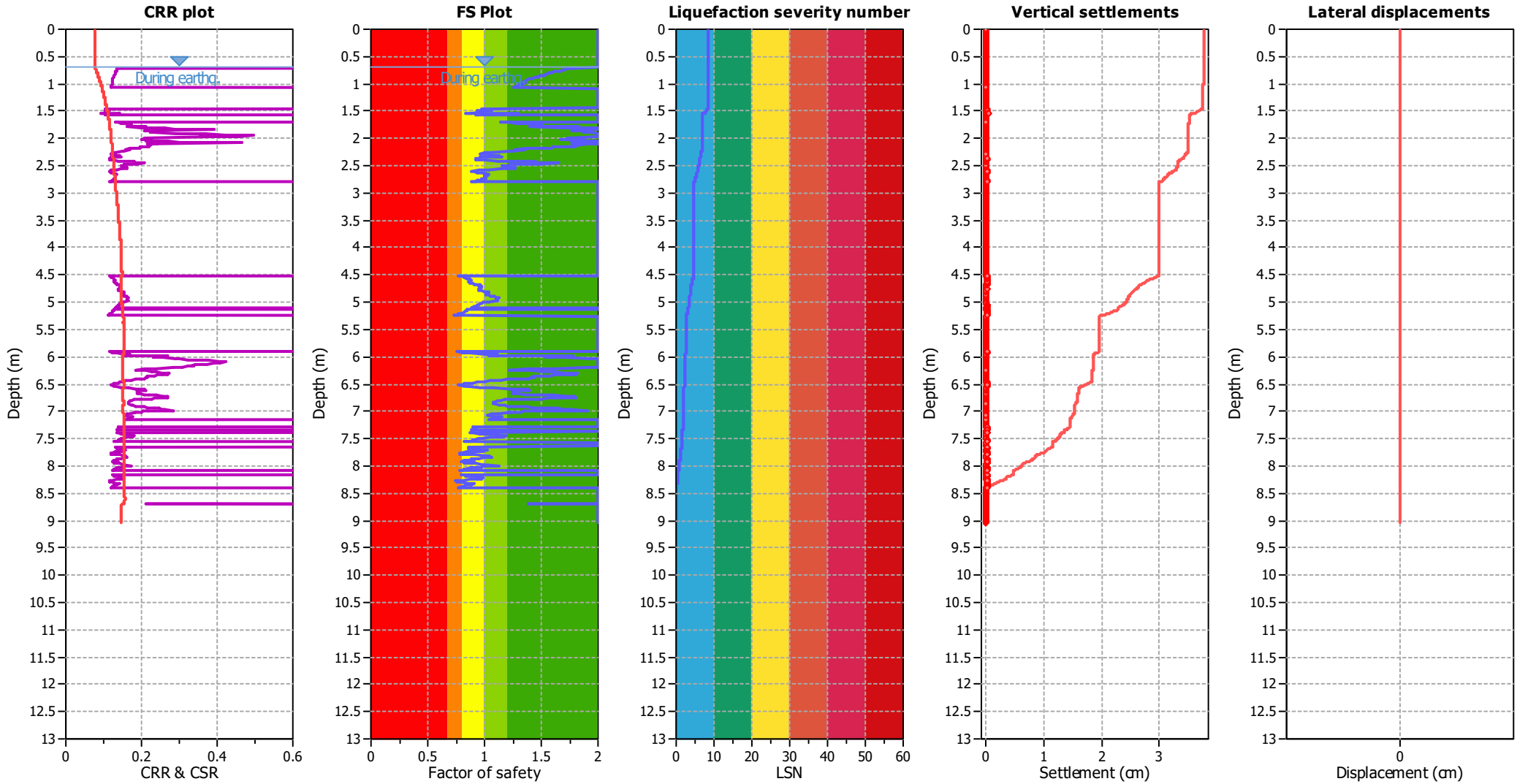
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.70 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_v applied:	Yes
Earthquake magnitude M_w :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.13	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.20 m	Fill height:	N/A	Limit depth:	10.00 m

SBT legend

1. Sensitive fine grained	4. Clayey silt to silty	7. Gravely sand to sand
2. Organic material	5. Silty sand to sandy silt	8. Very stiff sand to
3. Clay to silty clay	6. Clean sand to silty sand	9. Very stiff fine grained

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.70 m
Fines correction method:	B&I (2014)	Average results interval:	3
Points to test:	Based on Ic value	Ic cut-off value:	2.60
Earthquake magnitude M_w :	7.50	Unit weight calculation:	Based on SBT
Peak ground acceleration:	0.13	Use fill:	No
Depth to water table (insitu):	1.20 m	Fill height:	N/A

Fill weight:	N/A
Transition detect. applied:	No
K_v applied:	Yes
Clay like behavior applied:	Sands only
Limit depth applied:	Yes
Limit depth:	10.00 m

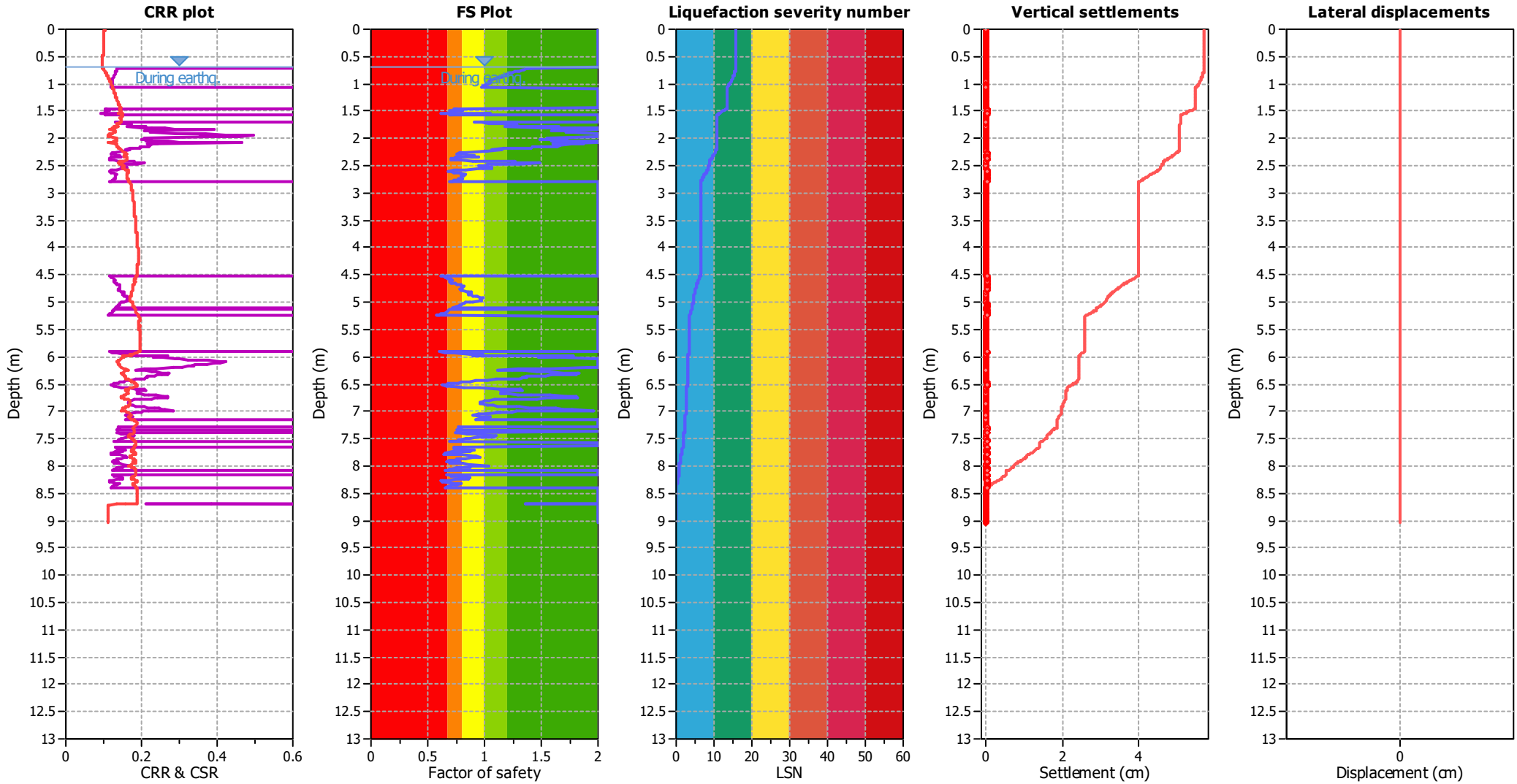
F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LSN color scheme

- Severe damage
- Major expression of liquefaction
- Moderate to severe exp. of liquefaction
- Moderate expression of liquefaction
- Minor expression of liquefaction
- Little to no expression of liquefaction

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.70 m
Fines correction method:	B&I (2014)	Average results interval:	3
Points to test:	Based on Ic value	Ic cut-off value:	2.60
Earthquake magnitude M_w :	6.00	Unit weight calculation:	Based on SBT
Peak ground acceleration:	0.19	Use fill:	No
Depth to water table (insitu):	1.20 m	Fill height:	N/A

Fill weight:	N/A
Transition detect. applied:	No
K_v applied:	Yes
Clay like behavior applied:	Sands only
Limit depth applied:	Yes
Limit depth:	10.00 m

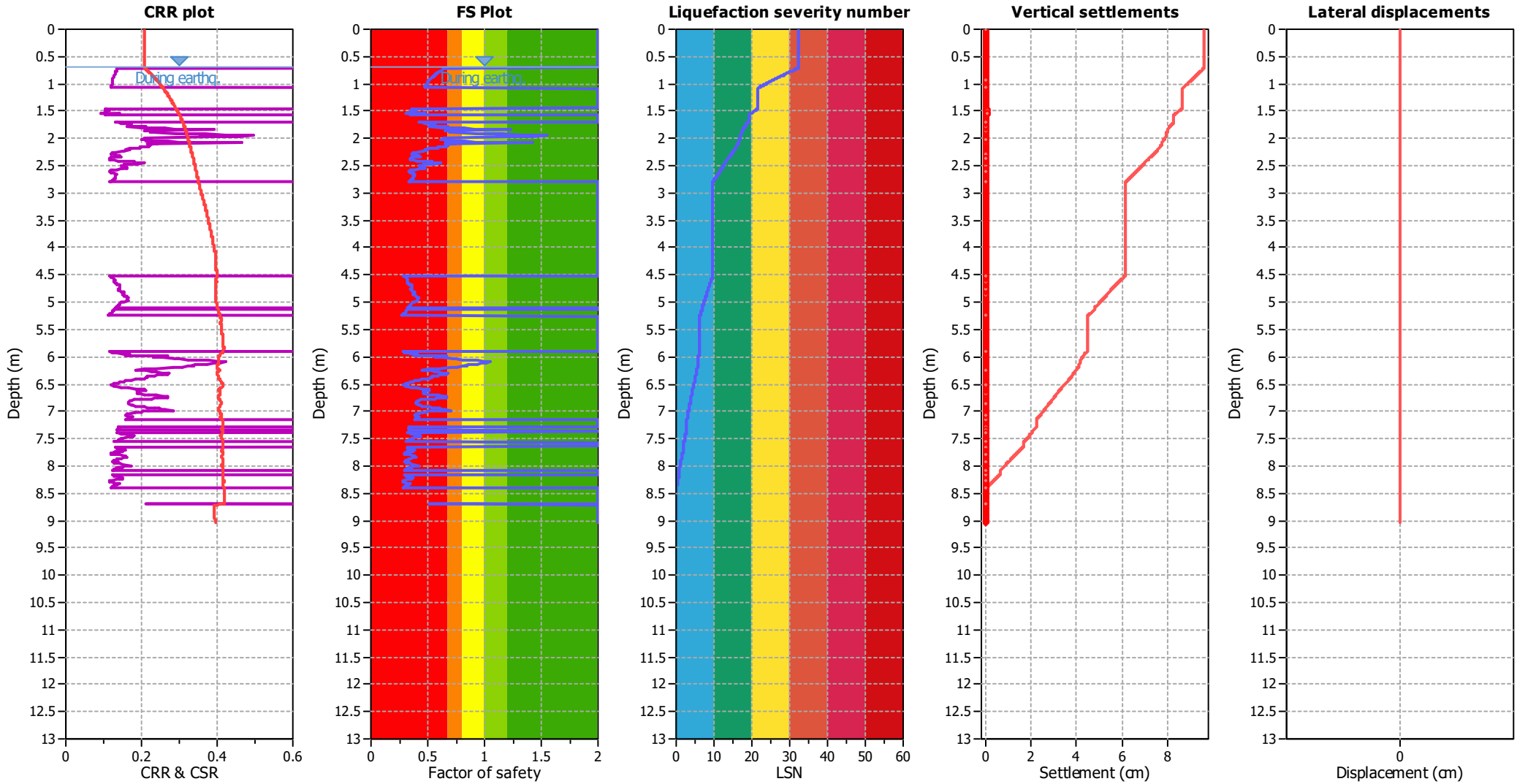
F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LSN color scheme

- Severe damage
- Major expression of liquefaction
- Moderate to severe exp. of liquefaction
- Moderate expression of liquefaction
- Minor expression of liquefaction
- Little to no expression of liquefaction

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.70 m
Fines correction method:	B&I (2014)	Average results interval:	3
Points to test:	Based on Ic value	Ic cut-off value:	2.60
Earthquake magnitude M_w :	7.50	Unit weight calculation:	Based on SBT
Peak ground acceleration:	0.35	Use fill:	No
Depth to water table (insitu):	1.20 m	Fill height:	N/A

Fill weight:	N/A
Transition detect. applied:	No
K_v applied:	Yes
Clay like behavior applied:	Sands only
Limit depth applied:	Yes
Limit depth:	10.00 m

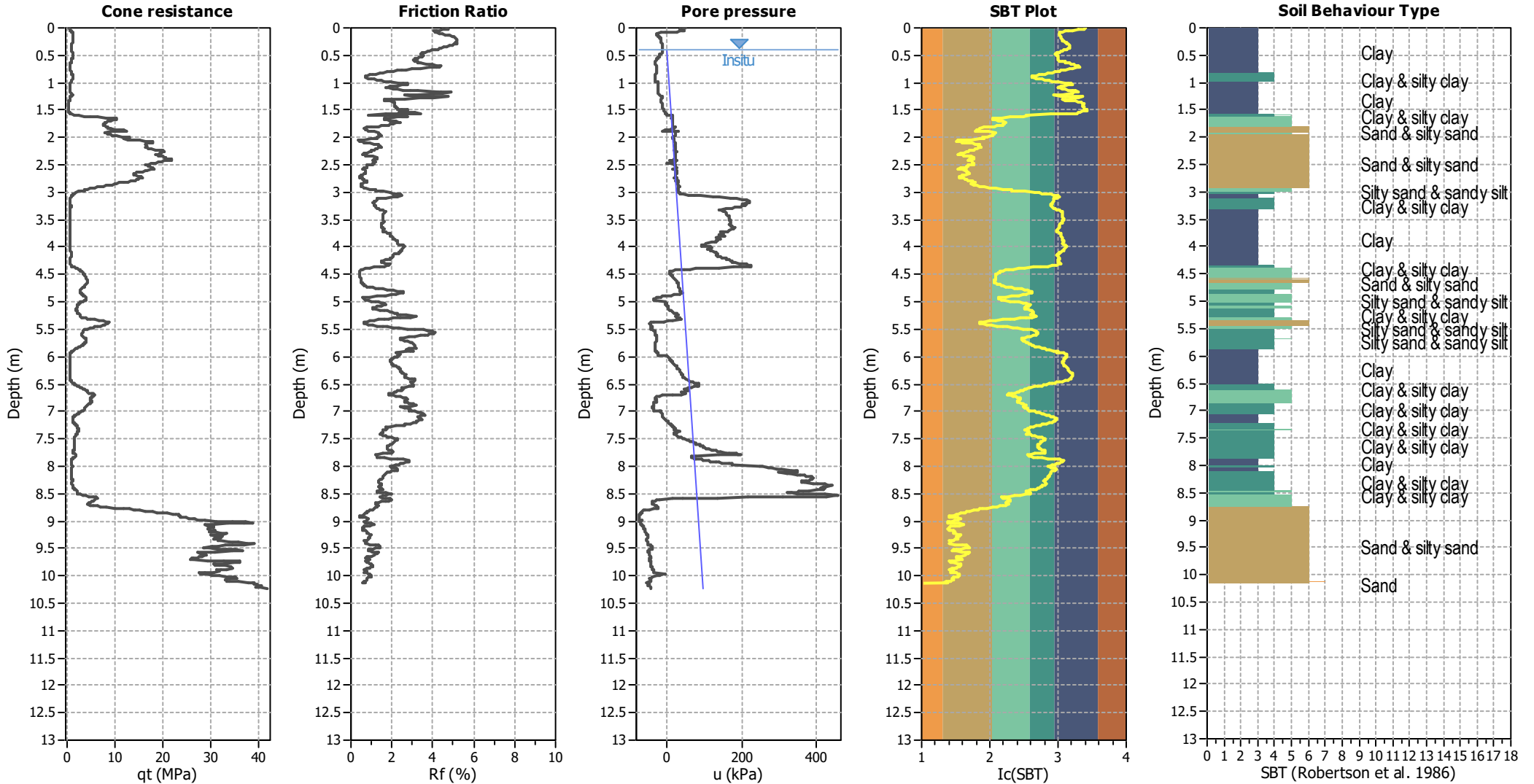
F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LSN color scheme

- Severe damage
- Major expression of liquefaction
- Moderate to severe exp. of liquefaction
- Moderate expression of liquefaction
- Minor expression of liquefaction
- Little to no expression of liquefaction

CPT basic interpretation plots



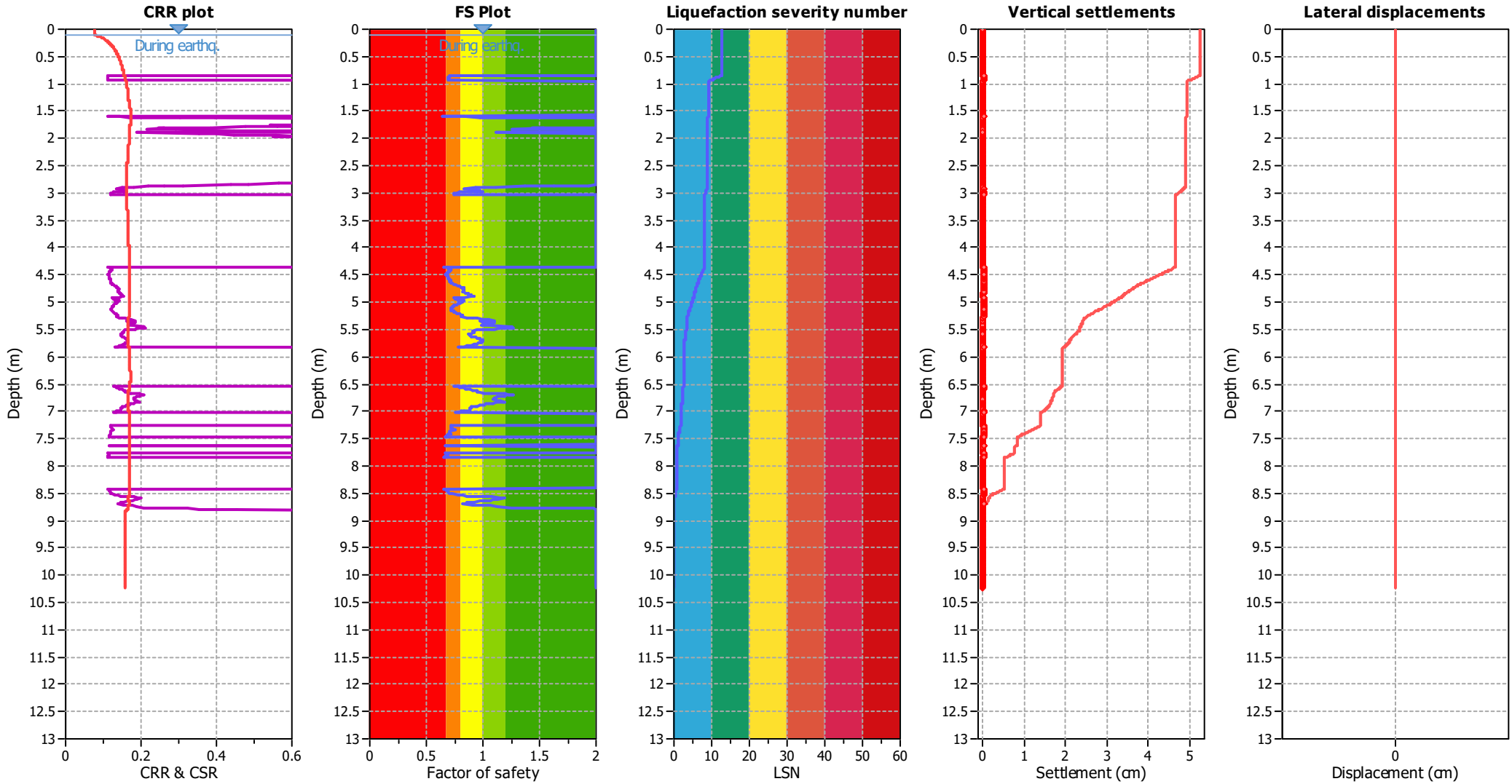
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.10 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_v applied:	Yes
Earthquake magnitude M_w :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.13	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	0.40 m	Fill height:	N/A	Limit depth:	10.00 m

SBT legend

■ 1. Sensitive fine grained	■ 4. Clayey silt to silty	■ 7. Gravely sand to sand
■ 2. Organic material	■ 5. Silty sand to sandy silt	■ 8. Very stiff sand to
■ 3. Clay to silty clay	■ 6. Clean sand to silty sand	■ 9. Very stiff fine grained

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.10 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_v applied:	Yes
Earthquake magnitude M_w :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.13	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	0.40 m	Fill height:	N/A	Limit depth:	10.00 m

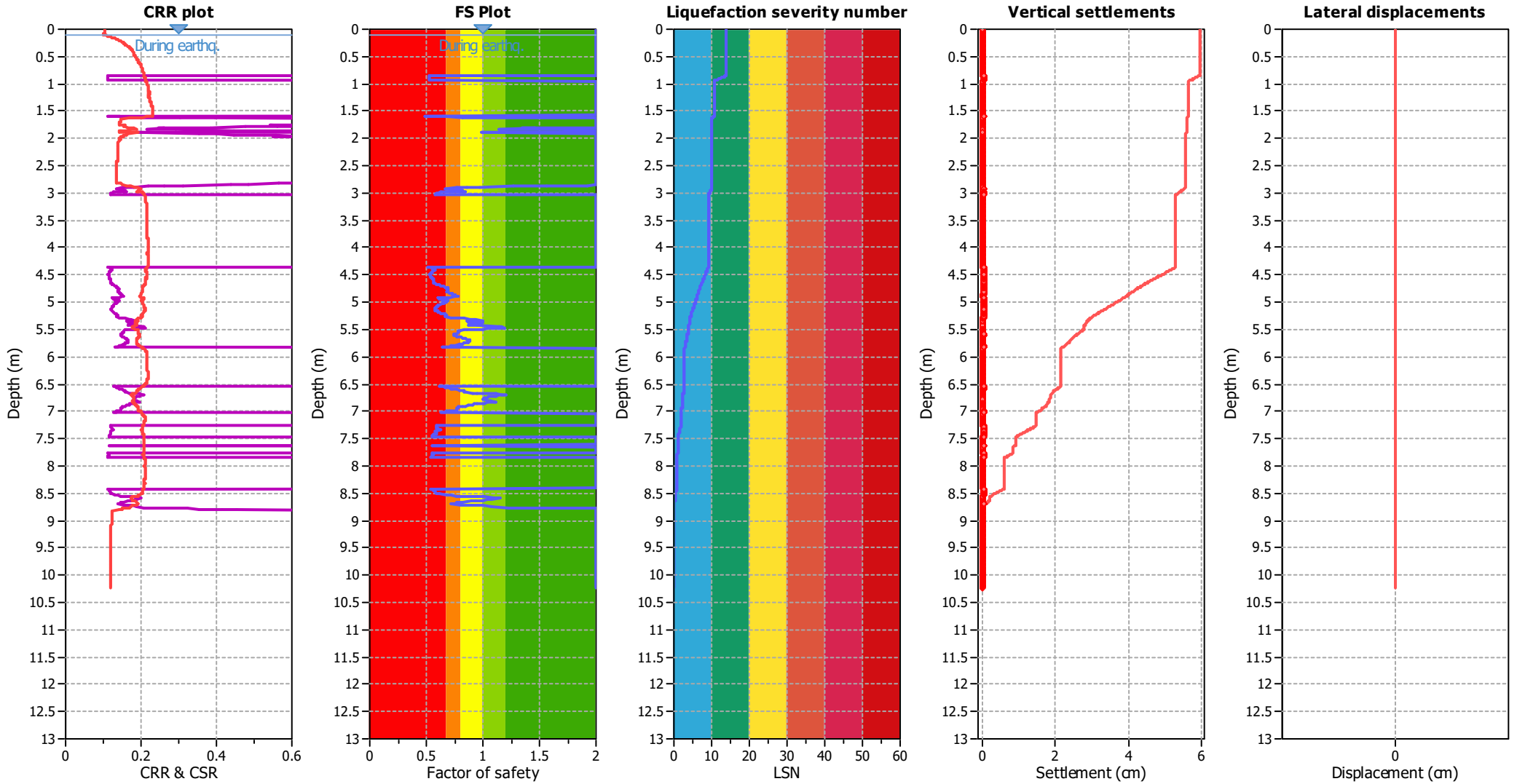
F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LSN color scheme

- Severe damage
- Major expression of liquefaction
- Moderate to severe exp. of liquefaction
- Moderate expression of liquefaction
- Minor expression of liquefaction
- Little to no expression of liquefaction

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.10 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_v applied:	Yes
Earthquake magnitude M_w :	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	0.40 m	Fill height:	N/A	Limit depth:	10.00 m

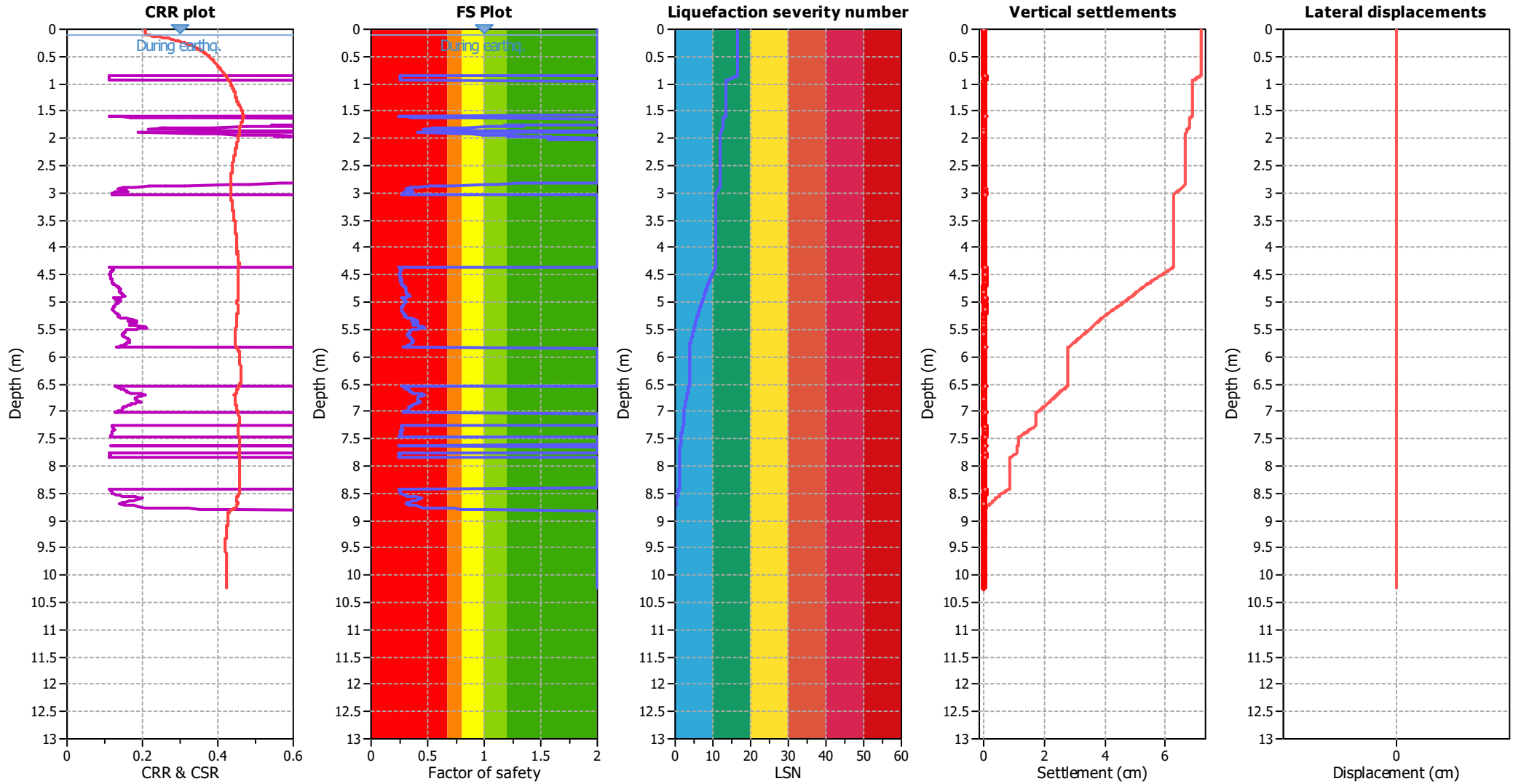
F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LSN color scheme

- Severe damage
- Major expression of liquefaction
- Moderate to severe exp. of liquefaction
- Moderate expression of liquefaction
- Minor expression of liquefaction
- Little to no expression of liquefaction

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.10 m
Fines correction method:	B&I (2014)	Average results interval:	3
Points to test:	Based on Ic value	Ic cut-off value:	2.60
Earthquake magnitude M_w :	7.50	Unit weight calculation:	Based on SBT
Peak ground acceleration:	0.35	Use fill:	No
Depth to water table (insitu):	0.40 m	Fill height:	N/A

Fill weight:	N/A
Transition detect. applied:	No
K_σ applied:	Yes
Clay like behavior applied:	Sands only
Limit depth applied:	Yes
Limit depth:	10.00 m

F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

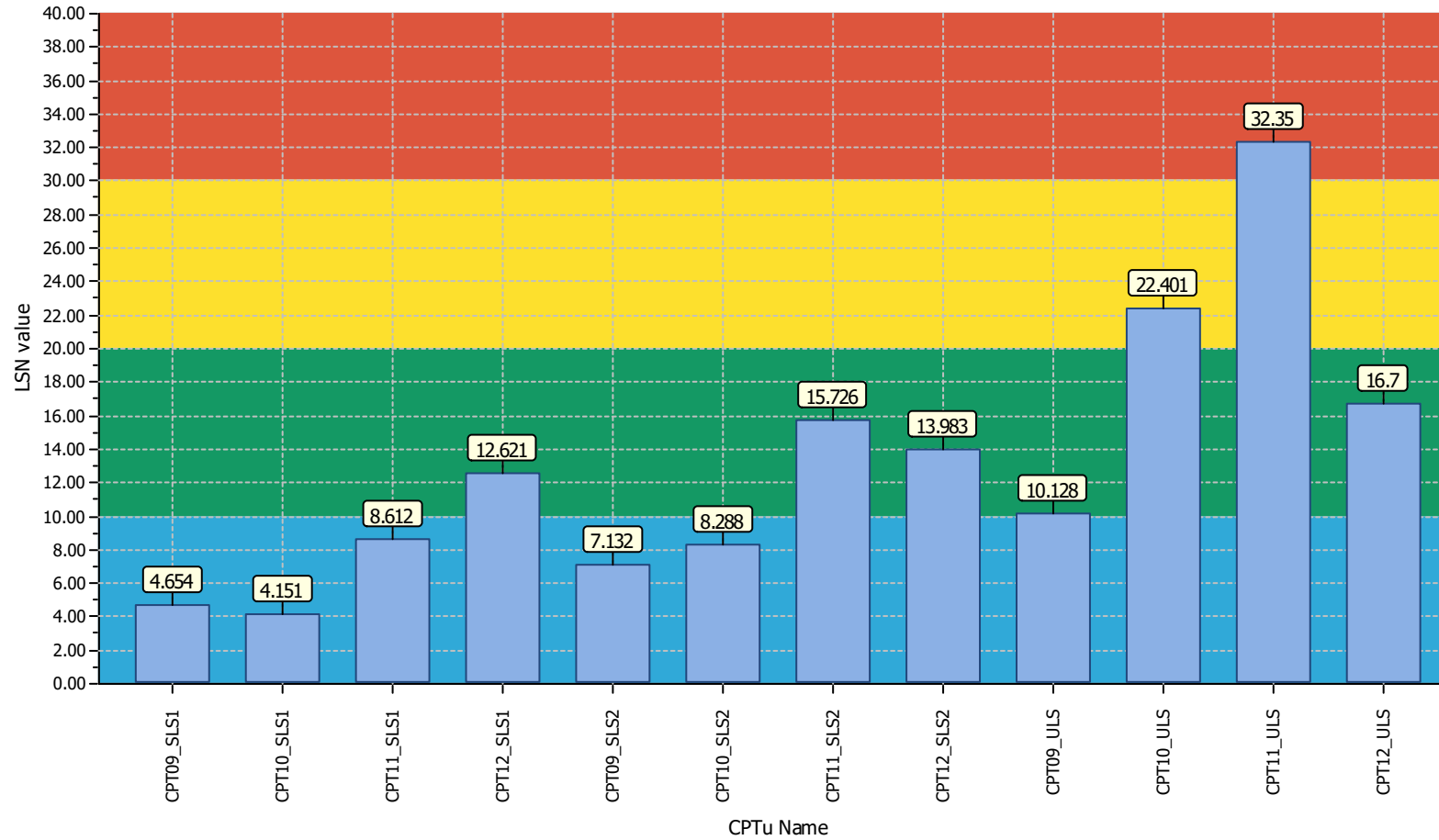
LSN color scheme

- Severe damage
- Major expression of liquefaction
- Moderate to severe exp. of liquefaction
- Moderate expression of liquefaction
- Minor expression of liquefaction
- Little to no expression of liquefaction

Project title : Liquefaction Assessment - 511185

Location : 518 Rangiora Woodend Road & 4 Golf Links Road

Overall Liquefaction Severity Number report



LSN color scheme

- Severe damage
- Major expression of liquefaction
- Moderate to severe exp. of liquefaction
- Moderate expression of liquefaction
- Minor expression of liquefaction
- Little to no expression of liquefaction

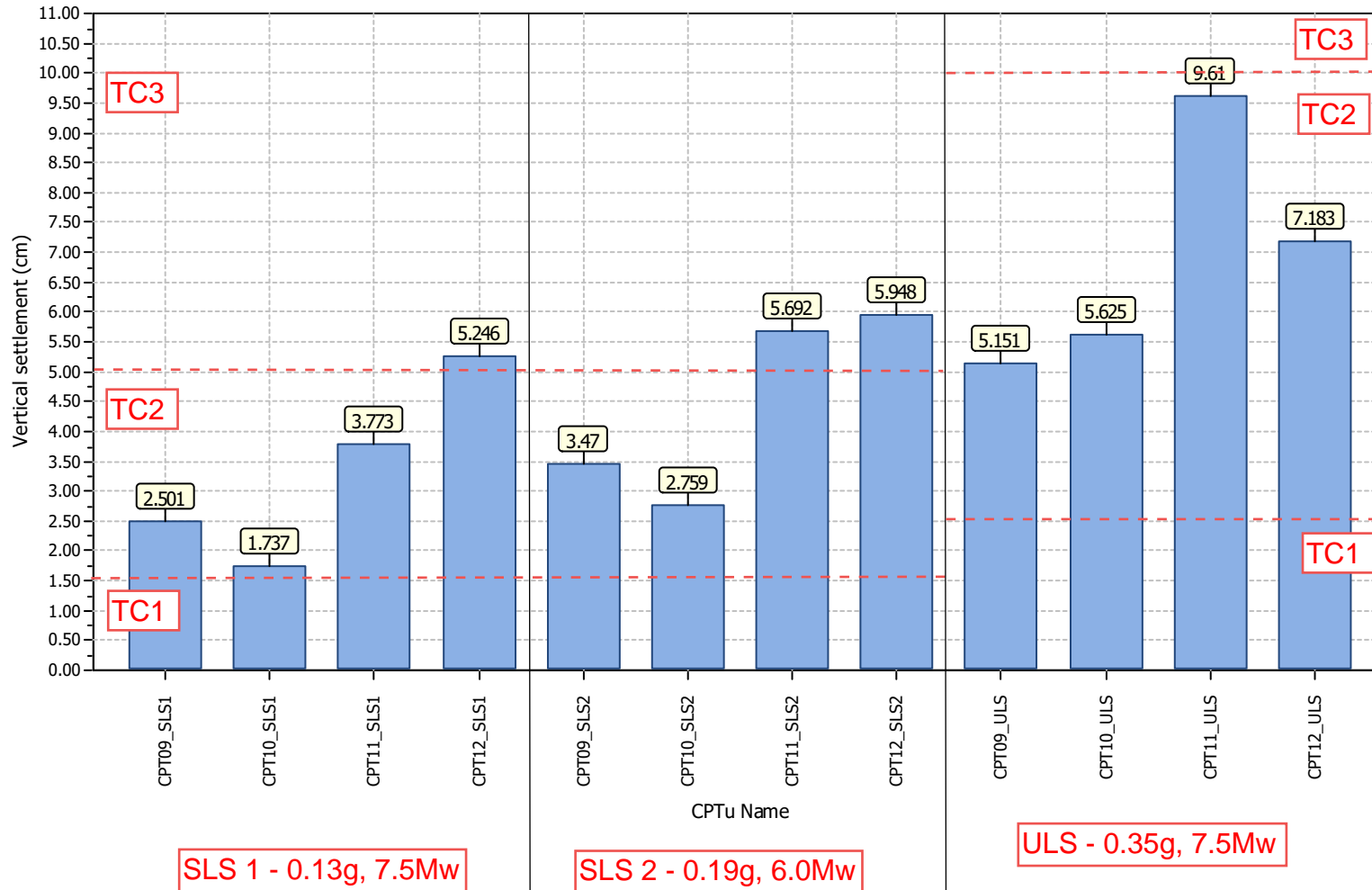
Basic statistics

- Total CPT number: 12
- 42% little liquefaction
- 42% minor liquefaction
- 8% moderate liquefaction
- 8% moderate to major liquefaction
- 0% major liquefaction
- 0% severe liquefaction

Project title : Liquefaction Assessment - 511185

Location : 518 Rangiora Woodend Road & 4 Golf Links Road

Overall vertical settlements report



Appendix E. SPT Based-Liquefaction Analysis Report

SPT BASED LIQUEFACTION ANALYSIS REPORT

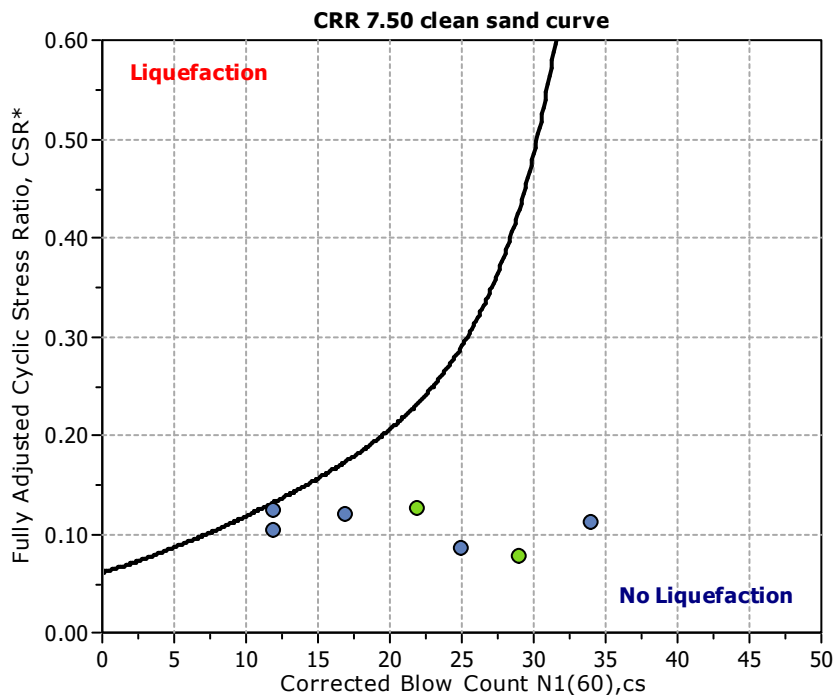
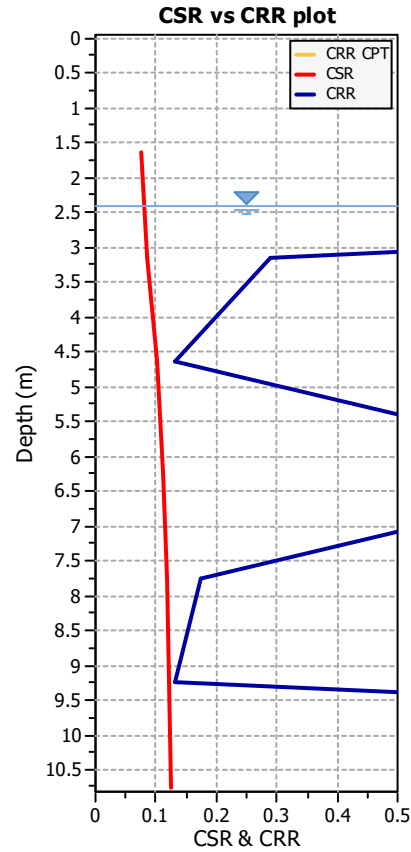
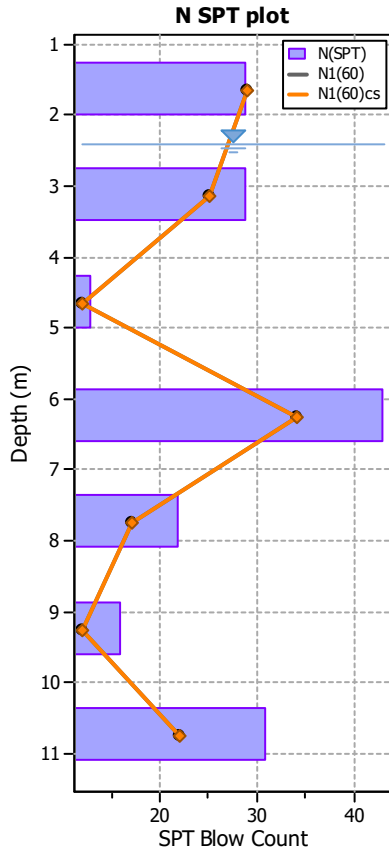
Project title : Liquefaction Assessment - 511185

Location : 518 Rangiora Woodend Road & 4 Golf Links Road

Borehole Name : BH01_SLS1

:: Input parameters and analysis properties ::

Analysis method:	Idriss & Boulanger 2014	G.W.T. (in-situ):	2.90	EQ site conditions:	Same as initial
Fines correction method:	Idriss & Boulanger 2014	G.W.T. (earthq.):	2.40		
Sampling method:	Standard Sample	Earthquake magnitude M_w :	7.50		
Borehole diameter:	65 mm to 115 mm	Peak ground acceleration:	0.13		
Rod length:	1.50	SPT results rounding mode:	Nearest		
Hammer energy ratio:	0.82				



:: Cyclic Stress Ratio fully adjusted (CSR*) numeric results ::												
No	Depth (m)	Weight (kN/m ³)	u ₀ (kPa)	σ _v (kPa)	Ext. Load (kPa)	σ' _v (kPa)	r _d	CSR	K _σ	MSF _{max}	MSF	CSR*
1	1.65	20.00	0.00	33.00	0.00	33.00	0.99	0.084	1.10	1.94	1.00	2.000
2	3.14	20.00	7.26	62.80	0.00	55.54	0.98	0.094	1.10	1.72	1.00	0.085
3	4.65	20.00	22.07	93.00	0.00	70.93	0.96	0.107	1.04	1.24	1.00	0.103
4	6.25	20.00	37.77	125.00	0.00	87.23	0.95	0.115	1.04	2.20	1.00	0.111
5	7.75	20.00	52.48	155.00	0.00	102.52	0.93	0.118	1.00	1.38	1.00	0.119
6	9.25	19.00	67.20	183.50	0.00	116.30	0.91	0.121	0.99	1.24	1.00	0.123
7	10.75	20.00	81.91	213.50	0.00	131.59	0.89	0.121	0.96	1.58	1.00	2.000

Abbreviations

- Depth: Depth from free surface where SPT was performed (m) during eq.
- u₀: Water pressure at test point (kPa) during eq.
- σ_v: Total overburden pressure at test point (kPa) during eq.
- σ'_v: Effective overburden pressure based on GWT during earthquake (kPa) during eq.
- r_d: Nonlinear shear mass factor
- CSR: Cyclic Stress Ratio
- MSF: Effective overburden stress factor
- K_σ: Magnitude Scaling Factor
- CSR*: CSR fully adjusted

:: Cyclic Resistance Ratio (CRR) numeric results ::																
No	Depth (m)	Fines %	u ₀ (kPa)	σ _v (kPa)	σ' _v (kPa)	N _{SPT}	C _N	C _R	C _B	C _S	C _E	N ₁₍₆₀₎	Δ(N ₁) ₆₀	N _{1(60),cs}	CRR _{7.5}	F.S.
1	1.65	2.42	0.00	33.00	33.00	29	1.52	0.80	1.00	1.00	0.82	29	0.00	29	4.000	2.00
2	3.14	0.00	2.35	62.80	60.45	29	1.23	0.85	1.00	1.00	0.82	25	0.00	25	0.290	2.00
3	4.65	0.00	17.17	93.00	75.83	13	1.16	0.95	1.00	1.00	0.82	12	0.00	12	0.132	1.28
4	6.25	0.00	32.86	125.00	92.14	43	1.03	0.95	1.00	1.00	0.82	34	0.00	34	0.909	2.00
5	7.75	0.00	47.58	155.00	107.42	22	0.97	0.95	1.00	1.00	0.82	17	0.00	17	0.174	1.47
6	9.25	1.50	62.29	183.50	121.21	16	0.91	1.00	1.00	1.00	0.82	12	0.00	12	0.132	1.08
7	10.75	0.00	77.01	213.50	136.49	31	0.88	1.00	1.00	1.00	0.82	22	0.00	22	4.000	2.00

Abbreviations

- Depth: Depth from free surface where SPT was performed (m)
- Weight: Soil unit weight from previous test point to current (kN/m³)
- u₀: Water pressure at test point (kPa)
- σ_v: Total overburden pressure at test point (kPa)
- σ'_v: Effective overburden pressure based on in situ GWT (kPa)
- N_{SPT}: Number of blows count in the field (blows/30 cm)
- C_N: Overburden pressure factor
- C_E: Energy ratio factor
- C_B: Borehole diameter factor
- C_R: Rod length factor
- C_S: Sampling method factor
- N₁₍₆₀₎: Number of blows corrected for 60% energy
- ΔN_{1(60),cs}: Fines correction
- N_{1(60),cs}: Number of blows corrected for 60% energy and fines
- CRR_{7.5}: Cyclic Resistance Ratio for M_w 7.50
- F.S.: Factor of safety against liquefaction

SPT BASED LIQUEFACTION ANALYSIS REPORT

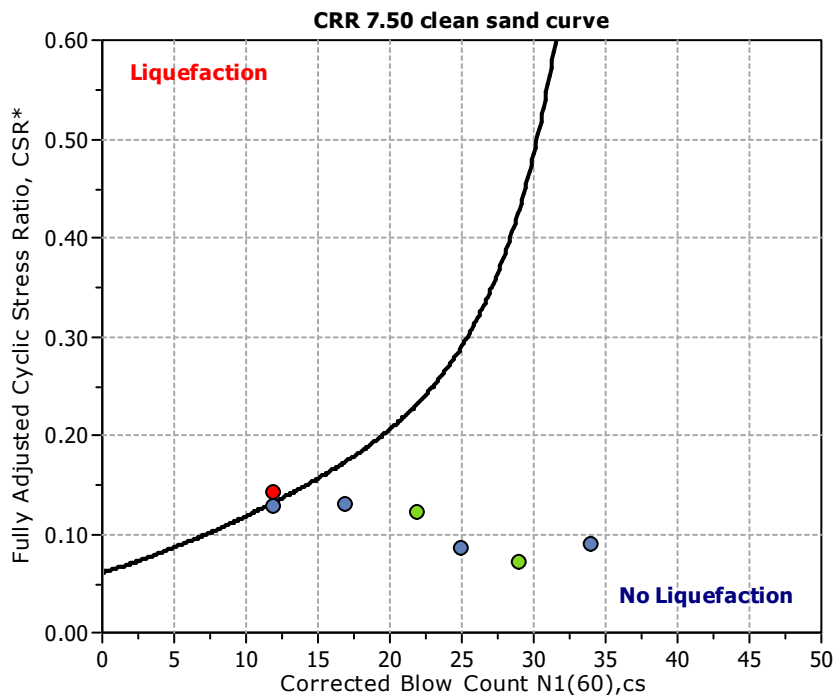
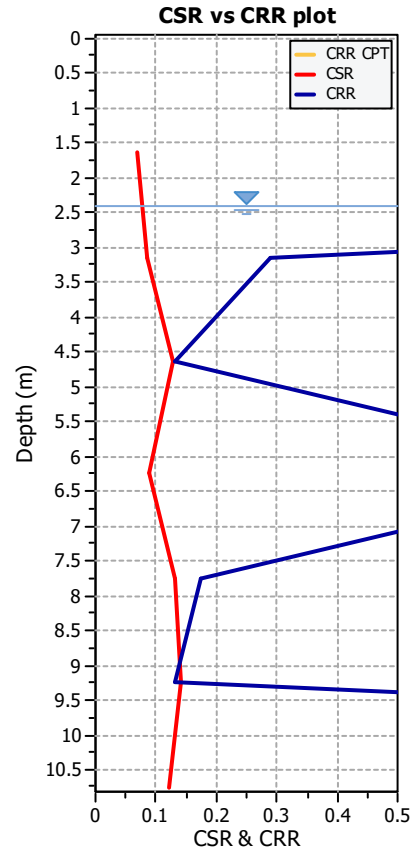
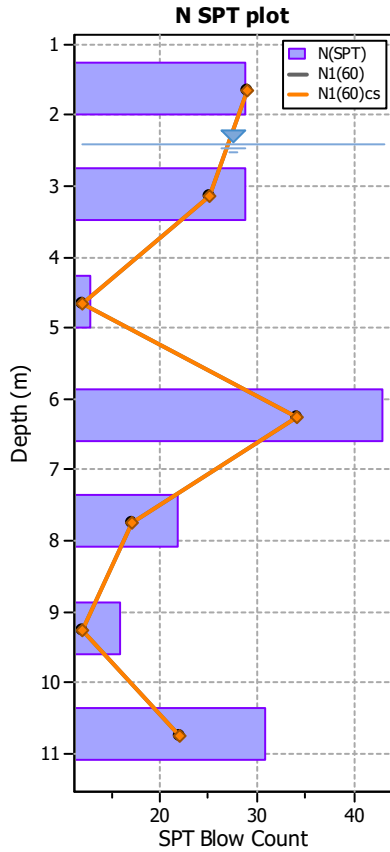
Project title : Liquefaction Assessment - 511185

Location : 518 Rangiora Woodend Road & 4 Golf Links Road

Borehole Name : BH01_SLS2

:: Input parameters and analysis properties ::

Analysis method:	Idriss & Boulanger 2014	G.W.T. (in-situ):	2.90	EQ site conditions:	Same as initial
Fines correction method:	Idriss & Boulanger 2014	G.W.T. (earthq.):	2.40		
Sampling method:	Standard Sample	Earthquake magnitude M_w :	6.00		
Borehole diameter:	65 mm to 115 mm	Peak ground acceleration:	0.19		
Rod length:	1.50	SPT results rounding mode:	Nearest		
Hammer energy ratio:	0.82				



:: Cyclic Stress Ratio fully adjusted (CSR*) numeric results ::												
No	Depth (m)	Weight (kN/m ³)	u ₀ (kPa)	σ _v (kPa)	Ext. Load (kPa)	σ' _v (kPa)	r _d	CSR	K _σ	MSF _{max}	MSF	CSR*
1	1.65	20.00	0.00	33.00	0.00	33.00	0.98	0.121	1.10	1.94	1.48	2.000
2	3.15	20.00	7.36	63.00	0.00	55.64	0.96	0.134	1.10	1.72	1.48	0.085
3	4.65	20.00	22.07	93.00	0.00	70.93	0.93	0.150	1.04	1.24	1.48	0.127
4	6.25	20.00	37.77	125.00	0.00	87.23	0.89	0.158	1.04	2.20	1.48	0.088
5	7.75	20.00	52.48	155.00	0.00	102.52	0.85	0.160	1.00	1.38	1.48	0.130
6	9.25	19.00	67.20	183.50	0.00	116.30	0.82	0.159	0.99	1.24	1.48	0.142
7	10.75	20.00	81.91	213.50	0.00	131.59	0.78	0.156	0.96	1.58	1.48	2.000

Abbreviations

Depth:	Depth from free surface where SPT was performed (m) during eq.
u ₀ :	Water pressure at test point (kPa) during eq.
σ _v :	Total overburden pressure at test point (kPa) during eq.
σ' _v :	Effective overburden pressure based on GWT during earthquake (kPa) during eq.
r _d :	Nonlinear shear mass factor
CSR:	Cyclic Stress Ratio
MSF:	Effective overburden stress factor
K _σ :	Magnitude Scaling Factor
CSR*:	CSR fully adjusted

:: Cyclic Resistance Ratio (CRR) numeric results ::																
No	Depth (m)	Fines %	u ₀ (kPa)	σ _v (kPa)	σ' _v (kPa)	N _{SPT}	C _N	C _R	C _B	C _S	C _E	N ₁₍₆₀₎	Δ(N ₁) ₆₀	N _{1(60),cs}	CRR _{7.5}	F.S.
1	1.65	2.42	0.00	33.00	33.00	29	1.52	0.80	1.00	1.00	0.82	29	0.00	29	4.000	2.00
2	3.15	0.00	2.45	63.00	60.55	29	1.23	0.85	1.00	1.00	0.82	25	0.00	25	0.290	2.00
3	4.65	0.00	17.17	93.00	75.83	13	1.16	0.95	1.00	1.00	0.82	12	0.00	12	0.132	1.04
4	6.25	0.00	32.86	125.00	92.14	43	1.03	0.95	1.00	1.00	0.82	34	0.00	34	0.909	2.00
5	7.75	0.00	47.58	155.00	107.42	22	0.97	0.95	1.00	1.00	0.82	17	0.00	17	0.174	1.34
6	9.25	1.50	62.29	183.50	121.21	16	0.91	1.00	1.00	1.00	0.82	12	0.00	12	0.132	0.94
7	10.75	0.00	77.01	213.50	136.49	31	0.88	1.00	1.00	1.00	0.82	22	0.00	22	4.000	2.00

Abbreviations

Depth:	Depth from free surface where SPT was performed (m)	C _B :	Borehole diameter factor
Weight:	Soil unit weight from previous test point to current (kN/m ³)	C _R :	Rod length factor
u ₀ :	Water pressure at test point (kPa)	C _S :	Sampling method factor
σ _v :	Total overburden pressure at test point (kPa)	N ₁₍₆₀₎ :	Number of blows corrected for 60% energy
σ' _v :	Effective overburden pressure based on in situ GWT (kPa)	ΔN _{1(60),cs} :	Fines correction
N _{SPT} :	Number of blows count in the field (blows/30 cm)	N _{1(60),cs} :	Number of blows corrected for 60% energy and fines
C _N :	Overburden pressure factor	CRR _{7.5} :	Cyclic Resistance Ratio for M _w 7.50
C _E :	Energy ratio factor	F.S.:	Factor of safety against liquefaction

SPT BASED LIQUEFACTION ANALYSIS REPORT

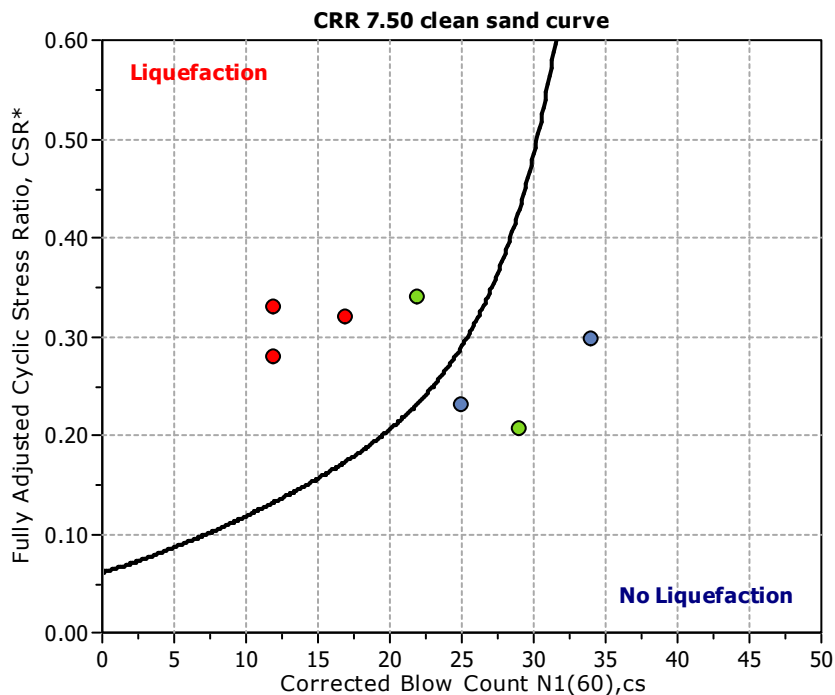
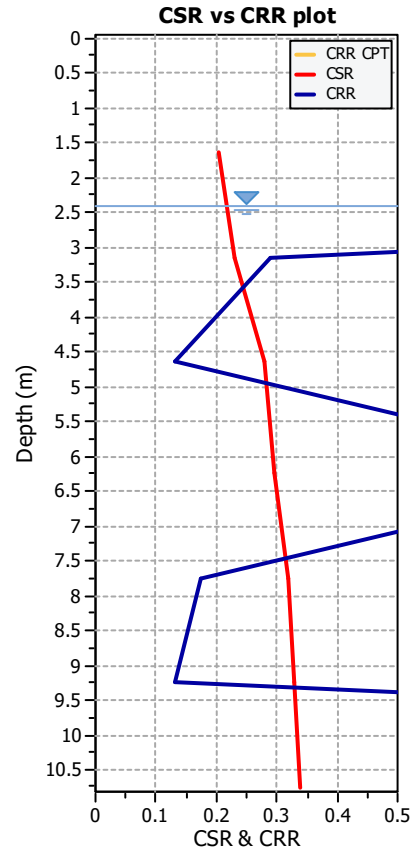
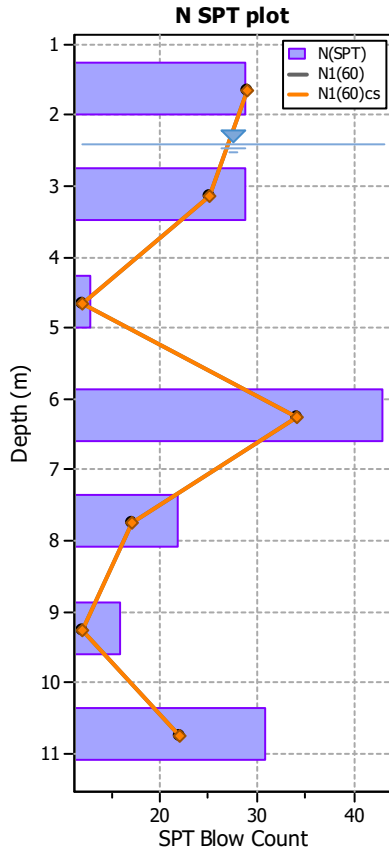
Project title : Liquefaction Assessment - 511185

Location : 518 Rangiora Woodend Road & 4 Golf Links Road

Borehole Name : BH01_ULS

:: Input parameters and analysis properties ::

Analysis method:	Idriss & Boulanger 2014	G.W.T. (in-situ):	2.90	EQ site conditions:	Same as initial
Fines correction method:	Idriss & Boulanger 2014	G.W.T. (earthq.):	2.40		
Sampling method:	Standard Sample	Earthquake magnitude M_w :	7.50		
Borehole diameter:	65 mm to 11 5mm	Peak ground acceleration:	0.35		
Rod length:	1.50	SPT results rounding mode:	Nearest		
Hammer energy ratio:	0.82				



:: Cyclic Stress Ratio fully adjusted (CSR*) numeric results ::												
No	Depth (m)	Weight (kN/m ³)	u ₀ (kPa)	σ _v (kPa)	Ext. Load (kPa)	σ' _v (kPa)	r _d	CSR	K _σ	MSF _{max}	MSF	CSR*
1	1.65	20.00	0.00	33.00	0.00	33.00	0.99	0.226	1.10	1.94	1.00	2.000
2	3.15	20.00	7.36	63.00	0.00	55.64	0.98	0.253	1.10	1.72	1.00	0.230
3	4.65	20.00	22.07	93.00	0.00	70.93	0.96	0.288	1.04	1.24	1.00	0.278
4	6.25	20.00	37.77	125.00	0.00	87.23	0.95	0.308	1.04	2.20	1.00	0.298
5	7.75	20.00	52.48	155.00	0.00	102.52	0.93	0.319	1.00	1.38	1.00	0.319
6	9.25	19.00	67.20	183.50	0.00	116.30	0.91	0.325	0.99	1.24	1.00	0.330
7	10.75	20.00	81.91	213.50	0.00	131.59	0.89	0.327	0.96	1.58	1.00	2.000

Abbreviations

- Depth: Depth from free surface where SPT was performed (m) during eq.
- u₀: Water pressure at test point (kPa) during eq.
- σ_v: Total overburden pressure at test point (kPa) during eq.
- σ'_v: Effective overburden pressure based on GWT during earthquake (kPa) during eq.
- r_d: Nonlinear shear mass factor
- CSR: Cyclic Stress Ratio
- MSF: Effective overburden stress factor
- K_σ: Magnitude Scaling Factor
- CSR*: CSR fully adjusted

:: Cyclic Resistance Ratio (CRR) numeric results ::																
No	Depth (m)	Fines %	u ₀ (kPa)	σ _v (kPa)	σ' _v (kPa)	N _{SPT}	C _N	C _R	C _B	C _S	C _E	N ₁₍₆₀₎	Δ(N ₁) ₆₀	N _{1(60),cs}	CRR _{7.5}	F.S.
1	1.65	2.42	0.00	33.00	33.00	29	1.52	0.80	1.00	1.00	0.82	29	0.00	29	4.000	2.00
2	3.15	0.00	2.45	63.00	60.55	29	1.23	0.85	1.00	1.00	0.82	25	0.00	25	0.290	1.26
3	4.65	0.00	17.17	93.00	75.83	13	1.16	0.95	1.00	1.00	0.82	12	0.00	12	0.132	0.48
4	6.25	0.00	32.86	125.00	92.14	43	1.03	0.95	1.00	1.00	0.82	34	0.00	34	0.909	2.00
5	7.75	0.00	47.58	155.00	107.42	22	0.97	0.95	1.00	1.00	0.82	17	0.00	17	0.174	0.54
6	9.25	1.50	62.29	183.50	121.21	16	0.91	1.00	1.00	1.00	0.82	12	0.00	12	0.132	0.40
7	10.75	0.00	77.01	213.50	136.49	31	0.88	1.00	1.00	1.00	0.82	22	0.00	22	4.000	2.00

Abbreviations

- Depth: Depth from free surface where SPT was performed (m)
- Weight: Soil unit weight from previous test point to current (kN/m³)
- u₀: Water pressure at test point (kPa)
- σ_v: Total overburden pressure at test point (kPa)
- σ'_v: Effective overburden pressure based on in situ GWT (kPa)
- N_{SPT}: Number of blows count in the field (blows/30 cm)
- C_N: Overburden pressure factor
- C_E: Energy ratio factor
- C_B: Borehole diameter factor
- C_R: Rod length factor
- C_S: Sampling method factor
- N₁₍₆₀₎: Number of blows corrected for 60% energy
- ΔN_{1(60),cs}: Fines correction
- N_{1(60),cs}: Number of blows corrected for 60% energy and fines
- CRR_{7.5}: Cyclic Resistance Ratio for M_w 7.50
- F.S.: Factor of safety against liquefaction

SPT BASED LIQUEFACTION ANALYSIS REPORT

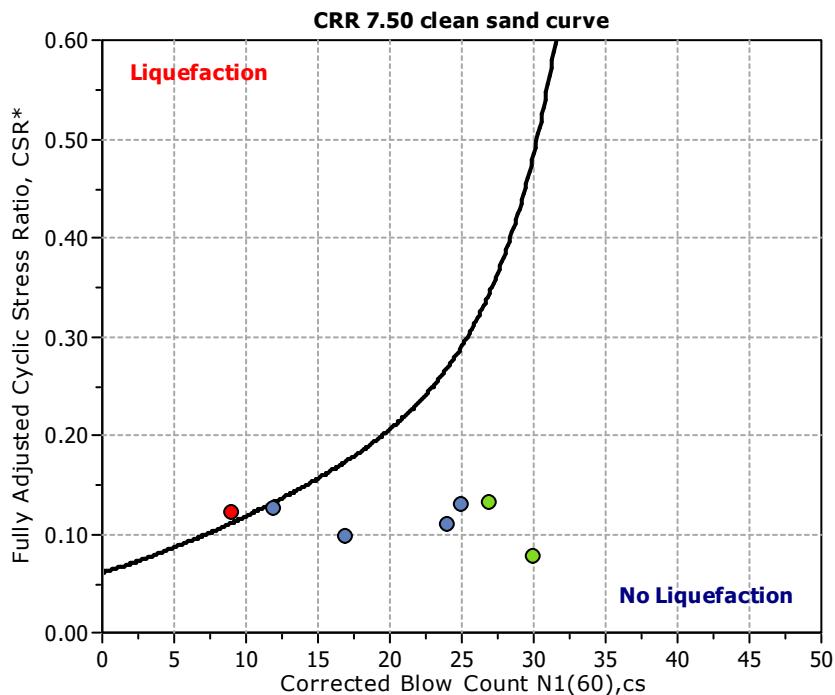
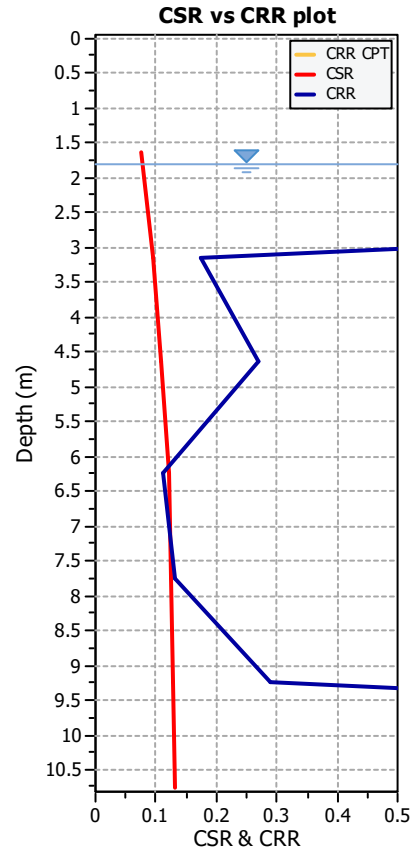
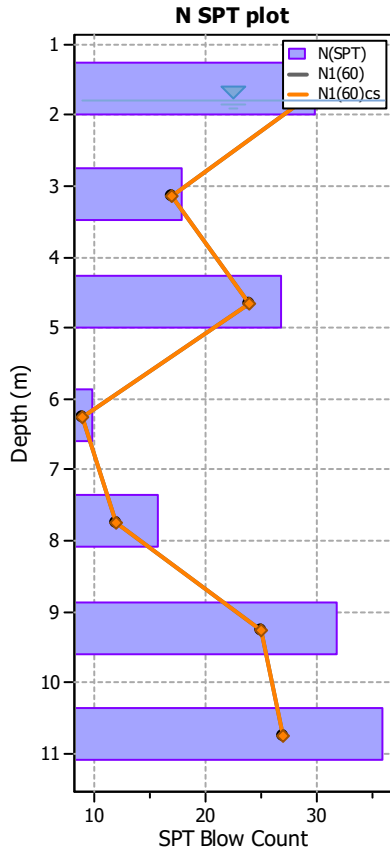
Project title : Liquefaction Assessment - 511185

Location : 518 Rangiora Woodend Road & 4 Golf Links Road

Borehole Name : BH02_SLS1

:: Input parameters and analysis properties ::

Analysis method:	Idriss & Boulanger 2014	G.W.T. (in-situ):	2.30	EQ site conditions:	Same as initial
Fines correction method:	Idriss & Boulanger 2014	G.W.T. (earthq.):	1.80		
Sampling method:	Standard Sample	Earthquake magnitude M_w :	7.50		
Borehole diameter:	65 mm to 115 mm	Peak ground acceleration:	0.13		
Rod length:	1.50	SPT results rounding mode:	Nearest		
Hammer energy ratio:	0.82				



:: Cyclic Stress Ratio fully adjusted (CSR*) numeric results ::												
No	Depth (m)	Weight (kN/m ³)	u ₀ (kPa)	σ _v (kPa)	Ext. Load (kPa)	σ' _v (kPa)	r _d	CSR	K _σ	MSF _{max}	MSF	CSR*
1	1.65	20.00	0.00	33.00	0.00	33.00	0.99	0.084	1.10	2.00	1.00	2.000
2	3.15	20.00	13.24	63.00	0.00	49.76	0.98	0.105	1.08	1.38	1.00	0.097
3	4.65	20.00	27.96	93.00	0.00	65.04	0.96	0.117	1.07	1.67	1.00	0.109
4	6.25	20.00	43.65	125.00	0.00	81.35	0.95	0.123	1.02	1.17	1.00	0.121
5	7.75	20.00	58.37	155.00	0.00	96.63	0.93	0.126	1.00	1.24	1.00	0.125
6	9.25	20.00	73.08	185.00	0.00	111.92	0.91	0.127	0.98	1.72	1.00	0.129
7	10.75	20.00	87.80	215.00	0.00	127.20	0.89	0.126	0.96	1.82	1.00	2.000

Abbreviations

- Depth: Depth from free surface where SPT was performed (m) during eq.
- u₀: Water pressure at test point (kPa) during eq.
- σ_v: Total overburden pressure at test point (kPa) during eq.
- σ'_v: Effective overburden pressure based on GWT during earthquake (kPa) during eq.
- r_d: Nonlinear shear mass factor
- CSR: Cyclic Stress Ratio
- MSF: Effective overburden stress factor
- K_σ: Magnitude Scaling Factor
- CSR*: CSR fully adjusted

:: Cyclic Resistance Ratio (CRR) numeric results ::																
No	Depth (m)	Fines %	u ₀ (kPa)	σ _v (kPa)	σ' _v (kPa)	N _{SPT}	C _N	C _R	C _B	C _S	C _E	N ₁₍₆₀₎	Δ(N ₁) ₆₀	N _{1(60),cs}	CRR _{7.5}	F.S.
1	1.65	1.86	0.00	33.00	33.00	30	1.50	0.80	1.00	1.00	0.82	30	0.00	30	4.000	2.00
2	3.15	0.00	8.34	63.00	54.66	18	1.33	0.85	1.00	1.00	0.82	17	0.00	17	0.174	1.80
3	4.65	0.00	23.05	93.00	69.95	27	1.16	0.95	1.00	1.00	0.82	24	0.00	24	0.268	2.00
4	6.25	0.00	38.75	125.00	86.25	10	1.09	0.95	1.00	1.00	0.82	9	0.00	9	0.111	0.92
5	7.75	0.00	53.46	155.00	101.54	16	1.00	0.95	1.00	1.00	0.82	12	0.00	12	0.132	1.06
6	9.25	0.00	68.18	185.00	116.82	32	0.94	1.00	1.00	1.00	0.82	25	0.00	25	0.290	2.00
7	10.75	0.00	82.89	215.00	132.11	36	0.90	1.00	1.00	1.00	0.82	27	0.00	27	4.000	2.00

Abbreviations

- Depth: Depth from free surface where SPT was performed (m)
- Weight: Soil unit weight from previous test point to current (kN/m³)
- u₀: Water pressure at test point (kPa)
- σ_v: Total overburden pressure at test point (kPa)
- σ'_v: Effective overburden pressure based on in situ GWT (kPa)
- N_{SPT}: Number of blows count in the field (blows/30 cm)
- C_N: Overburden pressure factor
- C_E: Energy ratio factor
- C_B: Borehole diameter factor
- C_R: Rod length factor
- C_S: Sampling method factor
- N₁₍₆₀₎: Number of blows corrected for 60% energy
- ΔN_{1(60),cs}: Fines correction
- N_{1(60),cs}: Number of blows corrected for 60% energy and fines
- CRR_{7.5}: Cyclic Resistance Ratio for M_w 7.50
- F.S.: Factor of safety against liquefaction

SPT BASED LIQUEFACTION ANALYSIS REPORT

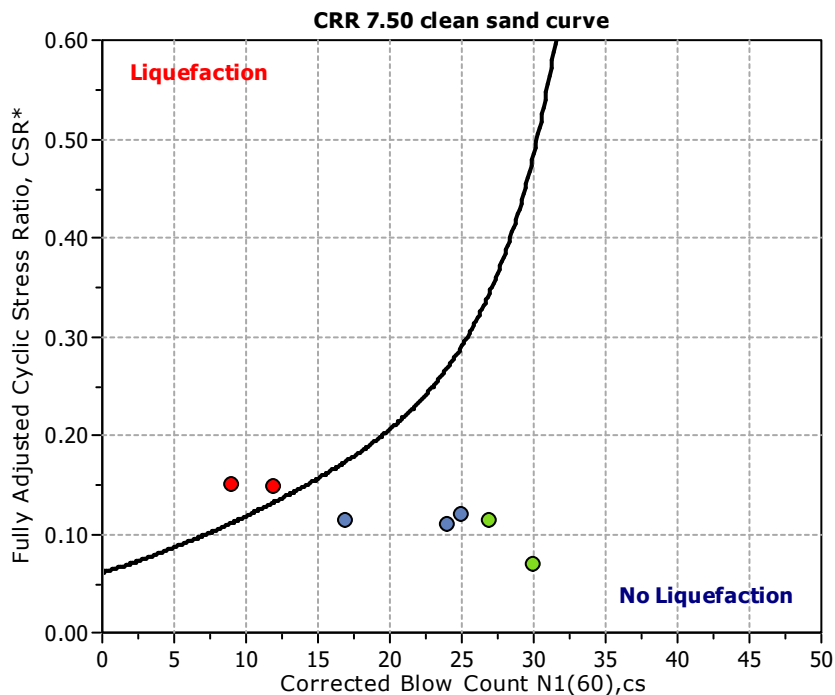
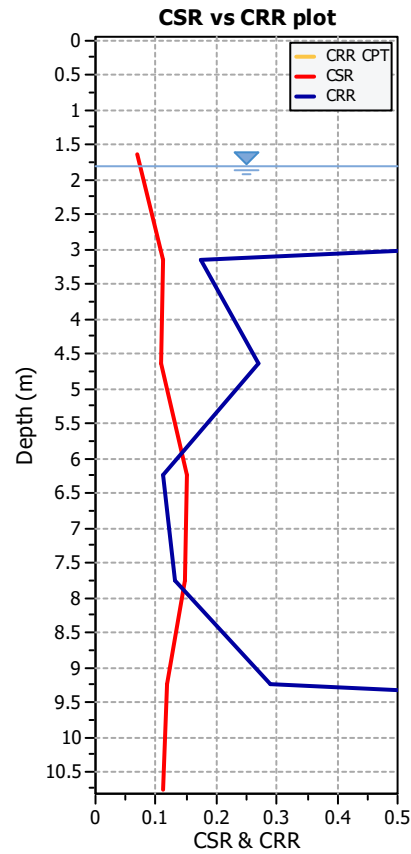
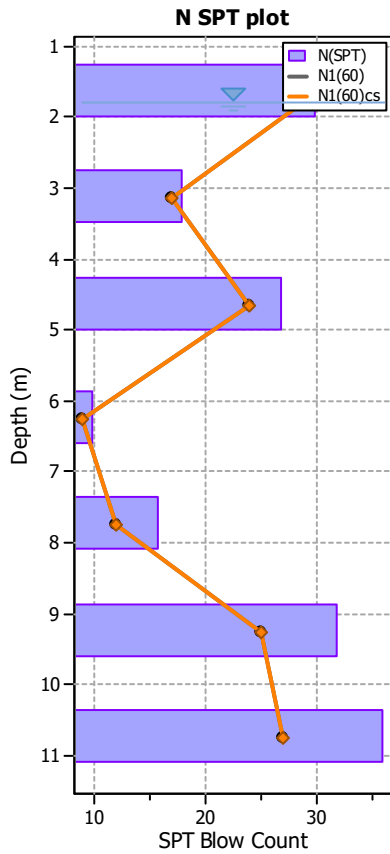
Project title : Liquefaction Assessment - 511185

Location : 518 Rangiora Woodend Road & 4 Golf Links Road

Borehole Name : BH02_SLS2

:: Input parameters and analysis properties ::

Analysis method:	Idriss & Boulanger 2014	G.W.T. (in-situ):	2.30	EQ site conditions:	Same as initial
Fines correction method:	Idriss & Boulanger 2014	G.W.T. (earthq.):	1.80		
Sampling method:	Standard Sample	Earthquake magnitude M_w :	6.00		
Borehole diameter:	65 mm to 115 mm	Peak ground acceleration:	0.19		
Rod length:	1.50	SPT results rounding mode:	Nearest		
Hammer energy ratio:	0.82				



:: Cyclic Stress Ratio fully adjusted (CSR*) numeric results ::

No	Depth (m)	Weight (kN/m ³)	u ₀ (kPa)	σ _v (kPa)	Ext. Load (kPa)	σ' _v (kPa)	r _d	CSR	K _σ	MSF _{max}	MSF	CSR*
1	1.65	20.00	0.00	33.00	0.00	33.00	0.98	0.121	1.10	2.00	1.48	2.000
2	3.15	20.00	13.24	63.00	0.00	49.76	0.96	0.150	1.08	1.38	1.48	0.112
3	4.65	20.00	27.96	93.00	0.00	65.04	0.93	0.164	1.07	1.67	1.48	0.109
4	6.25	20.00	43.65	125.00	0.00	81.35	0.89	0.169	1.02	1.17	1.48	0.150
5	7.75	20.00	58.37	155.00	0.00	96.63	0.85	0.169	1.00	1.24	1.48	0.148
6	9.25	20.00	73.08	185.00	0.00	111.92	0.82	0.167	0.98	1.72	1.48	0.118
7	10.75	20.00	87.80	215.00	0.00	127.20	0.78	0.163	0.96	1.82	1.48	2.000

Abbreviations

- Depth: Depth from free surface where SPT was performed (m) during eq.
- u₀: Water pressure at test point (kPa) during eq.
- σ_v: Total overburden pressure at test point (kPa) during eq.
- σ'_v: Effective overburden pressure based on GWT during earthquake (kPa) during eq.
- r_d: Nonlinear shear mass factor
- CSR: Cyclic Stress Ratio
- MSF: Effective overburden stress factor
- K_σ: Magnitude Scaling Factor
- CSR*: CSR fully adjusted

:: Cyclic Resistance Ratio (CRR) numeric results ::

No	Depth (m)	Fines %	u ₀ (kPa)	σ _v (kPa)	σ' _v (kPa)	N _{SPT}	C _N	C _R	C _B	C _S	C _E	N ₁₍₆₀₎	Δ(N ₁) ₆₀	N _{1(60),cs}	CRR _{7.5}	F.S.
1	1.65	1.86	0.00	33.00	33.00	30	1.50	0.80	1.00	1.00	0.82	30	0.00	30	4.000	2.00
2	3.15	0.00	8.34	63.00	54.66	18	1.33	0.85	1.00	1.00	0.82	17	0.00	17	0.174	1.55
3	4.65	0.00	23.05	93.00	69.95	27	1.16	0.95	1.00	1.00	0.82	24	0.00	24	0.268	2.00
4	6.25	0.00	38.75	125.00	86.25	10	1.09	0.95	1.00	1.00	0.82	9	0.00	9	0.111	0.74
5	7.75	0.00	53.46	155.00	101.54	16	1.00	0.95	1.00	1.00	0.82	12	0.00	12	0.132	0.90
6	9.25	0.00	68.18	185.00	116.82	32	0.94	1.00	1.00	1.00	0.82	25	0.00	25	0.290	2.00
7	10.75	0.00	82.89	215.00	132.11	36	0.90	1.00	1.00	1.00	0.82	27	0.00	27	4.000	2.00

Abbreviations

- Depth: Depth from free surface where SPT was performed (m)
- Weight: Soil unit weight from previous test point to current (kN/m³)
- u₀: Water pressure at test point (kPa)
- σ_v: Total overburden pressure at test point (kPa)
- σ'_v: Effective overburden pressure based on in situ GWT (kPa)
- N_{SPT}: Number of blows count in the field (blows/30 cm)
- C_N: Overburden pressure factor
- C_E: Energy ratio factor
- C_B: Borehole diameter factor
- C_R: Rod length factor
- C_S: Sampling method factor
- N₁₍₆₀₎: Number of blows corrected for 60% energy
- ΔN_{1(60),cs}: Fines correction
- N_{1(60),cs}: Number of blows corrected for 60% energy and fines
- CRR_{7.5}: Cyclic Resistance Ratio for M_w 7.50
- F.S.: Factor of safety against liquefaction

SPT BASED LIQUEFACTION ANALYSIS REPORT

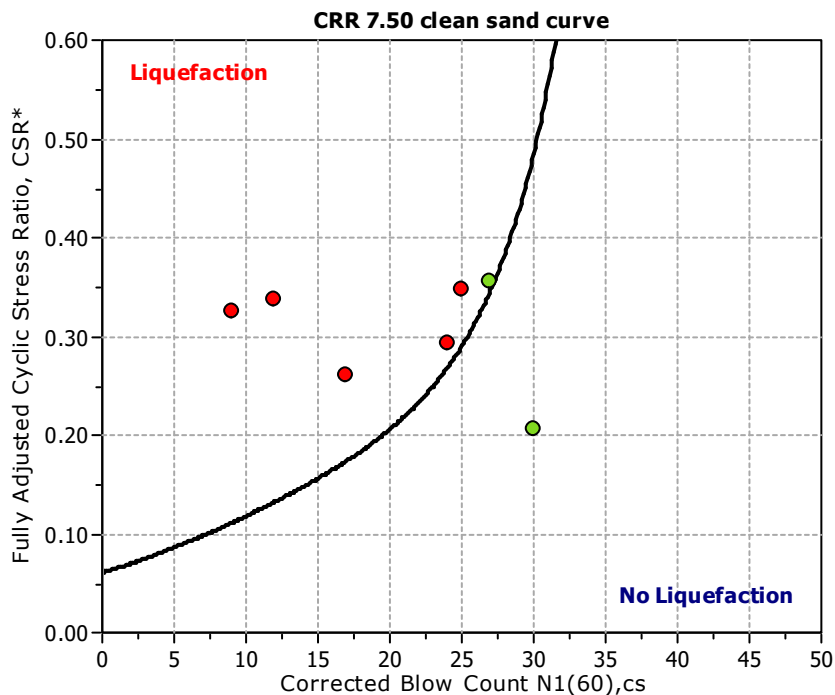
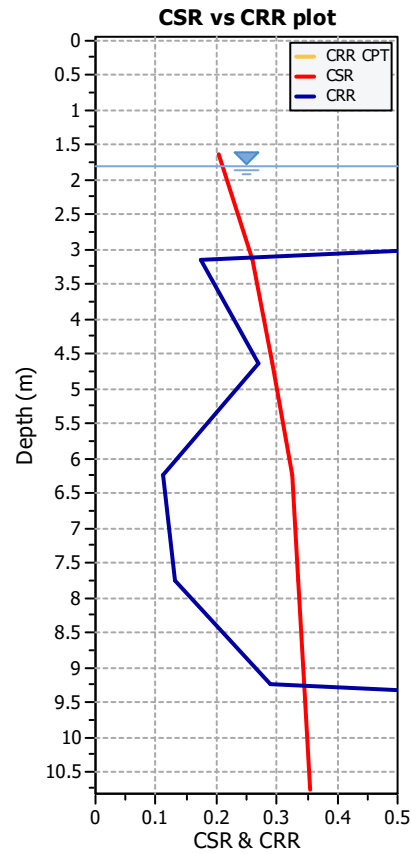
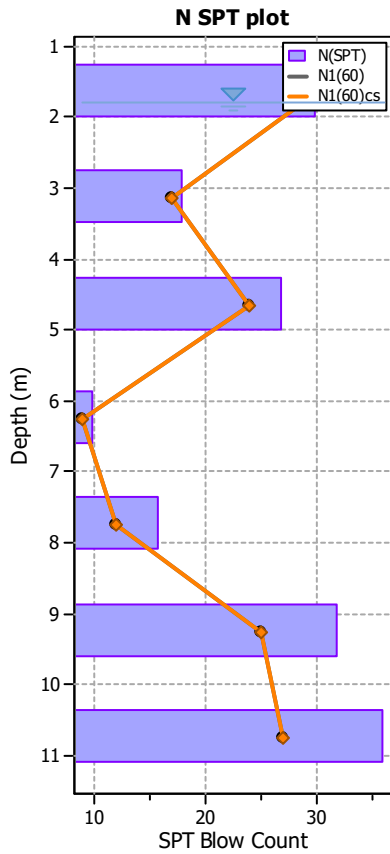
Project title : Liquefaction Assessment - 511185

Location : 518 Rangiora Woodend Road & 4 Golf Links Road

Borehole Name : BH02_ULS

:: Input parameters and analysis properties ::

Analysis method:	Idriss & Boulanger 2014	G.W.T. (in-situ):	2.30	EQ site conditions:	Same as initial
Fines correction method:	Idriss & Boulanger 2014	G.W.T. (earthq.):	1.80		
Sampling method:	Standard Sample	Earthquake magnitude M_w :	7.50		
Borehole diameter:	65 mm to 115 mm	Peak ground acceleration:	0.35		
Rod length:	1.50	SPT results rounding mode:	Nearest		
Hammer energy ratio:	0.82				



:: Cyclic Stress Ratio fully adjusted (CSR*) numeric results ::

No	Depth (m)	Weight (kN/m ³)	u ₀ (kPa)	σ _v (kPa)	Ext. Load (kPa)	σ' _v (kPa)	r _d	CSR	K _σ	MSF _{max}	MSF	CSR*
1	1.65	20.00	0.00	33.00	0.00	33.00	0.99	0.226	1.10	2.00	1.00	2.000
2	3.15	20.00	13.24	63.00	0.00	49.76	0.98	0.282	1.08	1.38	1.00	0.260
3	4.65	20.00	27.96	93.00	0.00	65.04	0.96	0.314	1.07	1.67	1.00	0.294
4	6.25	20.00	43.65	125.00	0.00	81.35	0.95	0.331	1.02	1.17	1.00	0.324
5	7.75	20.00	58.37	155.00	0.00	96.63	0.93	0.338	1.00	1.24	1.00	0.337
6	9.25	20.00	73.08	185.00	0.00	111.92	0.91	0.341	0.98	1.72	1.00	0.347
7	10.75	20.00	87.80	215.00	0.00	127.20	0.89	0.340	0.96	1.82	1.00	2.000

Abbreviations

- Depth: Depth from free surface where SPT was performed (m) during eq.
- u₀: Water pressure at test point (kPa) during eq.
- σ_v: Total overburden pressure at test point (kPa) during eq.
- σ'_v: Effective overburden pressure based on GWT during earthquake (kPa) during eq.
- r_d: Nonlinear shear mass factor
- CSR: Cyclic Stress Ratio
- MSF: Effective overburden stress factor
- K_σ: Magnitude Scaling Factor
- CSR*: CSR fully adjusted

:: Cyclic Resistance Ratio (CRR) numeric results ::

No	Depth (m)	Fines %	u ₀ (kPa)	σ _v (kPa)	σ' _v (kPa)	N _{SPT}	C _N	C _R	C _B	C _S	C _E	N ₁₍₆₀₎	Δ(N ₁) ₆₀	N _{1(60),cs}	CRR _{7.5}	F.S.
1	1.65	1.86	0.00	33.00	33.00	30	1.50	0.80	1.00	1.00	0.82	30	0.00	30	4.000	2.00
2	3.15	0.00	8.34	63.00	54.66	18	1.33	0.85	1.00	1.00	0.82	17	0.00	17	0.174	0.67
3	4.65	0.00	23.05	93.00	69.95	27	1.16	0.95	1.00	1.00	0.82	24	0.00	24	0.268	0.91
4	6.25	0.00	38.75	125.00	86.25	10	1.09	0.95	1.00	1.00	0.82	9	0.00	9	0.111	0.34
5	7.75	0.00	53.46	155.00	101.54	16	1.00	0.95	1.00	1.00	0.82	12	0.00	12	0.132	0.39
6	9.25	0.00	68.18	185.00	116.82	32	0.94	1.00	1.00	1.00	0.82	25	0.00	25	0.290	0.84
7	10.75	0.00	82.89	215.00	132.11	36	0.90	1.00	1.00	1.00	0.82	27	0.00	27	4.000	2.00

Abbreviations

- Depth: Depth from free surface where SPT was performed (m)
- Weight: Soil unit weight from previous test point to current (kN/m³)
- u₀: Water pressure at test point (kPa)
- σ_v: Total overburden pressure at test point (kPa)
- σ'_v: Effective overburden pressure based on in situ GWT (kPa)
- N_{SPT}: Number of blows count in the field (blows/30 cm)
- C_N: Overburden pressure factor
- C_E: Energy ratio factor
- C_B: Borehole diameter factor
- C_R: Rod length factor
- C_S: Sampling method factor
- N₁₍₆₀₎: Number of blows corrected for 60% energy
- ΔN_{1(60),cs}: Fines correction
- N_{1(60),cs}: Number of blows corrected for 60% energy and fines
- CRR_{7.5}: Cyclic Resistance Ratio for M_w 7.50
- F.S.: Factor of safety against liquefaction

SPT BASED LIQUEFACTION ANALYSIS REPORT

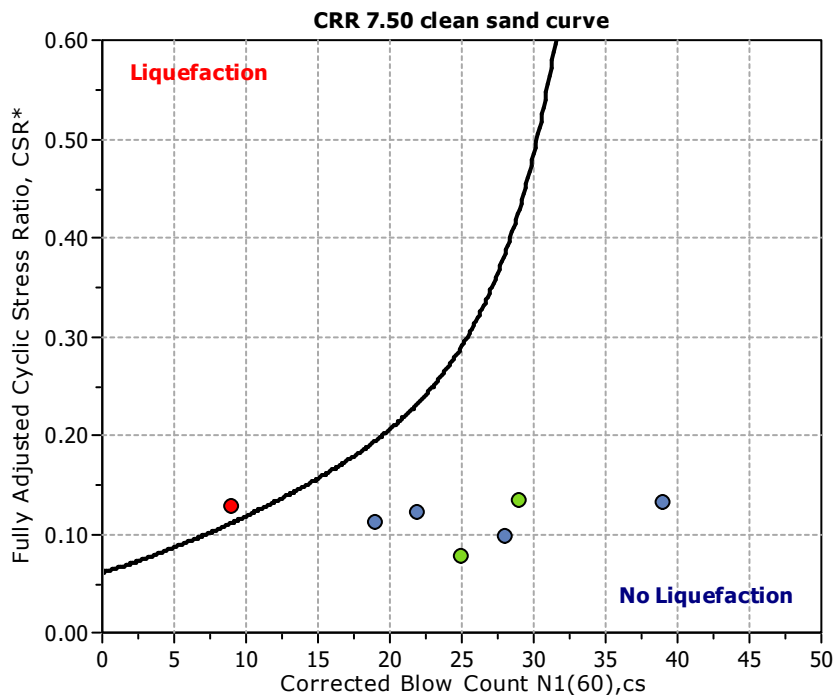
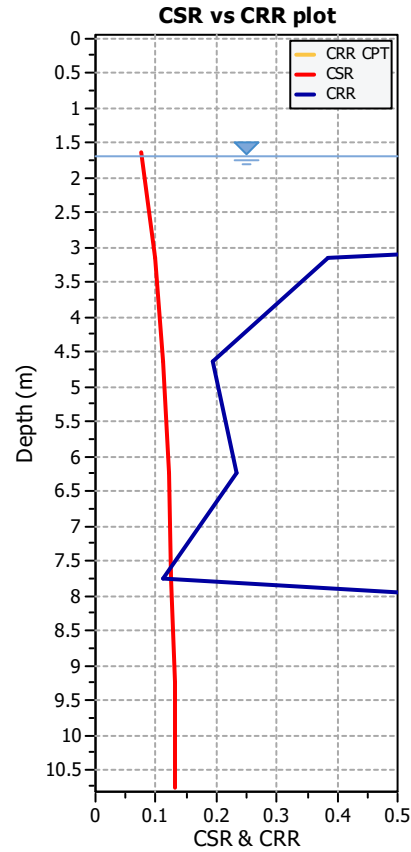
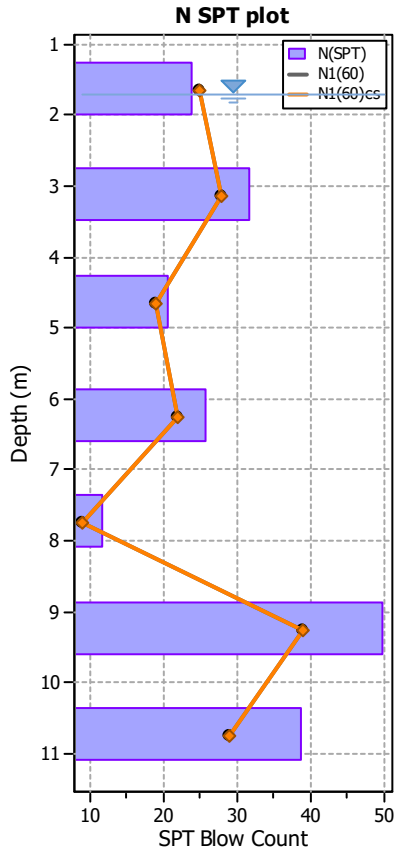
Project title : Liquefaction Assessment - 511185

Location : 518 Rangiora Woodend Road & 4 Golf Links Road

Borehole Name : BH03_SLS1

:: Input parameters and analysis properties ::

Analysis method:	Idriss & Boulanger 2014	G.W.T. (in-situ):	2.20	EQ site conditions:	Same as initial
Fines correction method:	Idriss & Boulanger 2014	G.W.T. (earthq.):	1.70		
Sampling method:	Standard Sample	Earthquake magnitude M_w :	7.50		
Borehole diameter:	65 mm to 115 mm	Peak ground acceleration:	0.13		
Rod length:	1.50	SPT results rounding mode:	Nearest		
Hammer energy ratio:	0.82				



:: Cyclic Stress Ratio fully adjusted (CSR*) numeric results ::												
No	Depth (m)	Weight (kN/m ³)	u ₀ (kPa)	σ _v (kPa)	Ext. Load (kPa)	σ' _v (kPa)	r _d	CSR	K _σ	MSF _{max}	MSF	CSR*
1	1.65	20.00	0.00	33.00	0.00	33.00	0.99	0.084	1.10	1.72	1.00	2.000
2	3.15	20.00	14.22	63.00	0.00	48.78	0.98	0.107	1.10	1.88	1.00	0.097
3	4.65	20.00	28.94	93.00	0.00	64.06	0.96	0.118	1.06	1.45	1.00	0.112
4	6.25	20.00	44.64	125.00	0.00	80.36	0.95	0.124	1.03	1.58	1.00	0.120
5	7.75	20.00	59.35	155.00	0.00	95.65	0.93	0.127	1.00	1.17	1.00	0.126
6	9.25	20.00	74.07	185.00	0.00	110.93	0.91	0.128	0.97	2.20	1.00	0.131
7	10.75	20.00	88.78	215.00	0.00	126.22	0.89	0.127	0.96	1.94	1.00	2.000

Abbreviations

- Depth: Depth from free surface where SPT was performed (m) during eq.
- u₀: Water pressure at test point (kPa) during eq.
- σ_v: Total overburden pressure at test point (kPa) during eq.
- σ'_v: Effective overburden pressure based on GWT during earthquake (kPa) during eq.
- r_d: Nonlinear shear mass factor
- CSR: Cyclic Stress Ratio
- MSF: Effective overburden stress factor
- K_σ: Magnitude Scaling Factor
- CSR*: CSR fully adjusted

:: Cyclic Resistance Ratio (CRR) numeric results ::																
No	Depth (m)	Fines %	u ₀ (kPa)	σ _v (kPa)	σ' _v (kPa)	N _{SPT}	C _N	C _R	C _B	C _S	C _E	N ₁₍₆₀₎	Δ(N ₁) ₆₀	N _{1(60),cs}	CRR _{7.5}	F.S.
1	1.65	3.43	0.00	33.00	33.00	24	1.57	0.80	1.00	1.00	0.82	25	0.00	25	4.000	2.00
2	3.15	7.04	9.32	63.00	53.68	32	1.27	0.85	1.00	1.00	0.82	28	0.14	28	0.384	2.00
3	4.65	0.00	24.03	93.00	68.97	21	1.19	0.95	1.00	1.00	0.82	19	0.00	19	0.194	1.74
4	6.25	0.00	39.73	125.00	85.27	26	1.08	0.95	1.00	1.00	0.82	22	0.00	22	0.233	1.94
5	7.75	0.00	54.45	155.00	100.55	12	1.00	0.95	1.00	1.00	0.82	9	0.00	9	0.111	0.88
6	9.25	0.00	69.16	185.00	115.84	50	0.96	1.00	1.00	1.00	0.82	39	0.00	39	3.025	2.00
7	10.75	0.00	83.88	215.00	131.12	39	0.91	1.00	1.00	1.00	0.82	29	0.00	29	4.000	2.00

Abbreviations

- Depth: Depth from free surface where SPT was performed (m)
- Weight: Soil unit weight from previous test point to current (kN/m³)
- u₀: Water pressure at test point (kPa)
- σ_v: Total overburden pressure at test point (kPa)
- σ'_v: Effective overburden pressure based on in situ GWT (kPa)
- N_{SPT}: Number of blows count in the field (blows/30 cm)
- C_N: Overburden pressure factor
- C_E: Energy ratio factor
- C_B: Borehole diameter factor
- C_R: Rod length factor
- C_S: Sampling method factor
- N₁₍₆₀₎: Number of blows corrected for 60% energy
- ΔN_{1(60),cs}: Fines correction
- N_{1(60),cs}: Number of blows corrected for 60% energy and fines
- CRR_{7.5}: Cyclic Resistance Ratio for M_w 7.50
- F.S.: Factor of safety against liquefaction

SPT BASED LIQUEFACTION ANALYSIS REPORT

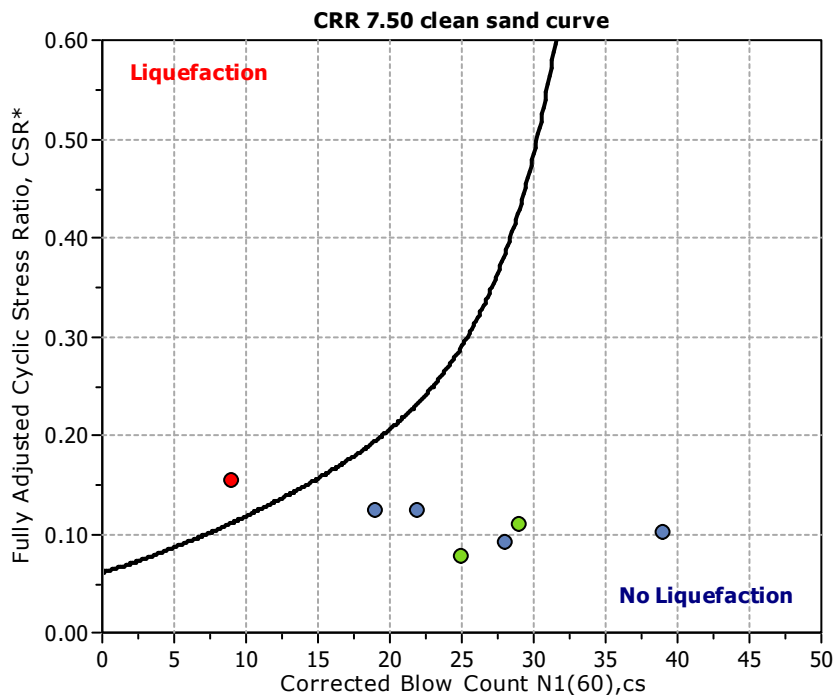
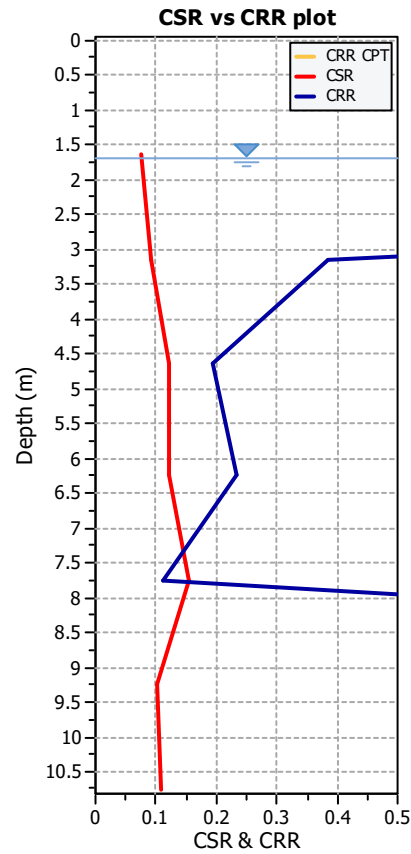
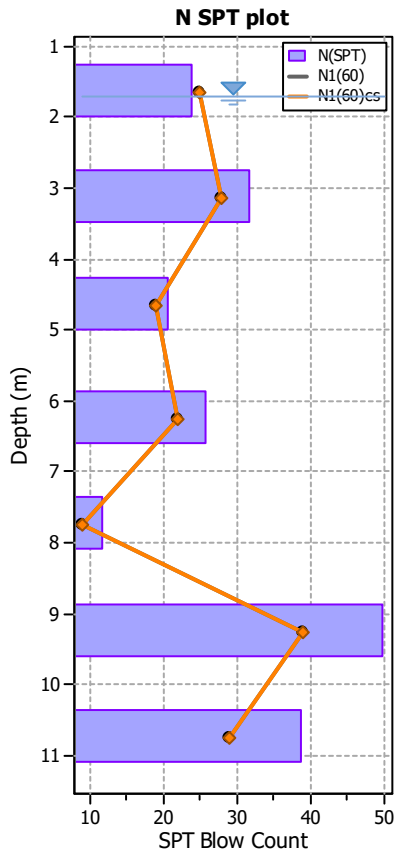
Project title : Liquefaction Assessment - 511185

Location : 518 Rangiora Woodend Road & 4 Golf Links Road

Borehole Name : BH03_SLS2

:: Input parameters and analysis properties ::

Analysis method:	Idriss & Boulanger 2014	G.W.T. (in-situ):	2.20	EQ site conditions:	Same as initial
Fines correction method:	Idriss & Boulanger 2014	G.W.T. (earthq.):	1.70		
Sampling method:	Standard Sample	Earthquake magnitude M_w :	6.00		
Borehole diameter:	65 mm to 115 mm	Peak ground acceleration:	0.19		
Rod length:	1.50	SPT results rounding mode:	Nearest		
Hammer energy ratio:	0.82				



:: Cyclic Stress Ratio fully adjusted (CSR*) numeric results ::												
No	Depth (m)	Weight (kN/m ³)	u ₀ (kPa)	σ _v (kPa)	Ext. Load (kPa)	σ' _v (kPa)	r _d	CSR	K _σ	MSF _{max}	MSF	CSR*
1	1.65	20.00	0.00	33.00	0.00	33.00	0.98	0.121	1.10	1.72	1.48	2.000
2	3.15	20.00	14.22	63.00	0.00	48.78	0.96	0.153	1.10	1.88	1.48	0.091
3	4.65	20.00	28.94	93.00	0.00	64.06	0.93	0.166	1.06	1.45	1.48	0.123
4	6.25	20.00	44.64	125.00	0.00	80.36	0.89	0.171	1.03	1.58	1.48	0.123
5	7.75	20.00	59.35	155.00	0.00	95.65	0.85	0.171	1.00	1.17	1.48	0.154
6	9.25	20.00	74.07	185.00	0.00	110.93	0.82	0.168	0.97	2.20	1.48	0.101
7	10.75	20.00	88.78	215.00	0.00	126.22	0.78	0.164	0.96	1.94	1.48	2.000

Abbreviations

- Depth: Depth from free surface where SPT was performed (m) during eq.
- u₀: Water pressure at test point (kPa) during eq.
- σ_v: Total overburden pressure at test point (kPa) during eq.
- σ'_v: Effective overburden pressure based on GWT during earthquake (kPa) during eq.
- r_d: Nonlinear shear mass factor
- CSR: Cyclic Stress Ratio
- MSF: Effective overburden stress factor
- K_σ: Magnitude Scaling Factor
- CSR*: CSR fully adjusted

:: Cyclic Resistance Ratio (CRR) numeric results ::																
No	Depth (m)	Fines %	u ₀ (kPa)	σ _v (kPa)	σ' _v (kPa)	N _{SPT}	C _N	C _R	C _B	C _S	C _E	N ₁₍₆₀₎	Δ(N ₁) ₆₀	N _{1(60),cs}	CRR _{7.5}	F.S.
1	1.65	3.43	0.00	33.00	33.00	24	1.57	0.80	1.00	1.00	0.82	25	0.00	25	4.000	2.00
2	3.15	7.04	9.32	63.00	53.68	32	1.27	0.85	1.00	1.00	0.82	28	0.14	28	0.384	2.00
3	4.65	0.00	24.03	93.00	68.97	21	1.19	0.95	1.00	1.00	0.82	19	0.00	19	0.194	1.58
4	6.25	0.00	39.73	125.00	85.27	26	1.08	0.95	1.00	1.00	0.82	22	0.00	22	0.233	1.90
5	7.75	0.00	54.45	155.00	100.55	12	1.00	0.95	1.00	1.00	0.82	9	0.00	9	0.111	0.72
6	9.25	0.00	69.16	185.00	115.84	50	0.96	1.00	1.00	1.00	0.82	39	0.00	39	3.025	2.00
7	10.75	0.00	83.88	215.00	131.12	39	0.91	1.00	1.00	1.00	0.82	29	0.00	29	4.000	2.00

Abbreviations

- Depth: Depth from free surface where SPT was performed (m)
- Weight: Soil unit weight from previous test point to current (kN/m³)
- u₀: Water pressure at test point (kPa)
- σ_v: Total overburden pressure at test point (kPa)
- σ'_v: Effective overburden pressure based on in situ GWT (kPa)
- N_{SPT}: Number of blows count in the field (blows/30 cm)
- C_N: Overburden pressure factor
- C_E: Energy ratio factor
- C_B: Borehole diameter factor
- C_R: Rod length factor
- C_S: Sampling method factor
- N₁₍₆₀₎: Number of blows corrected for 60% energy
- ΔN_{1(60),cs}: Fines correction
- N_{1(60),cs}: Number of blows corrected for 60% energy and fines
- CRR_{7.5}: Cyclic Resistance Ratio for M_w 7.50
- F.S.: Factor of safety against liquefaction

SPT BASED LIQUEFACTION ANALYSIS REPORT

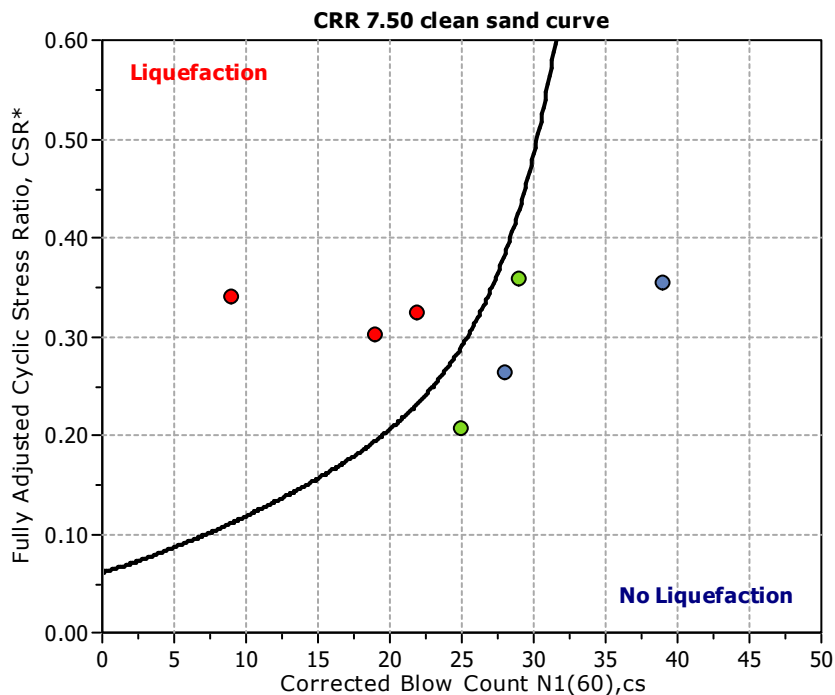
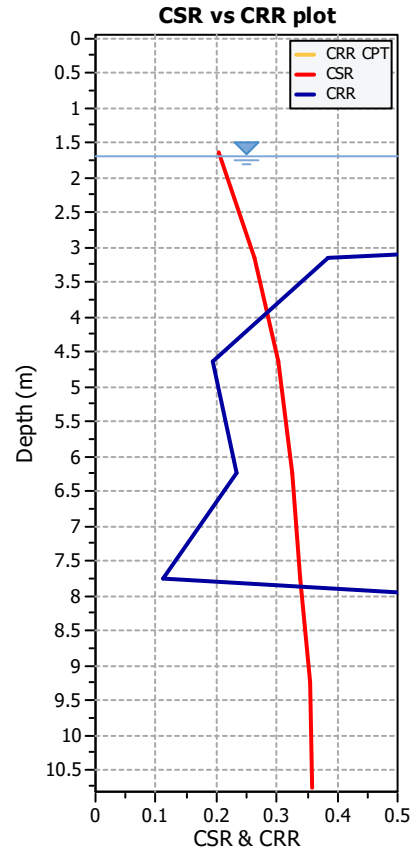
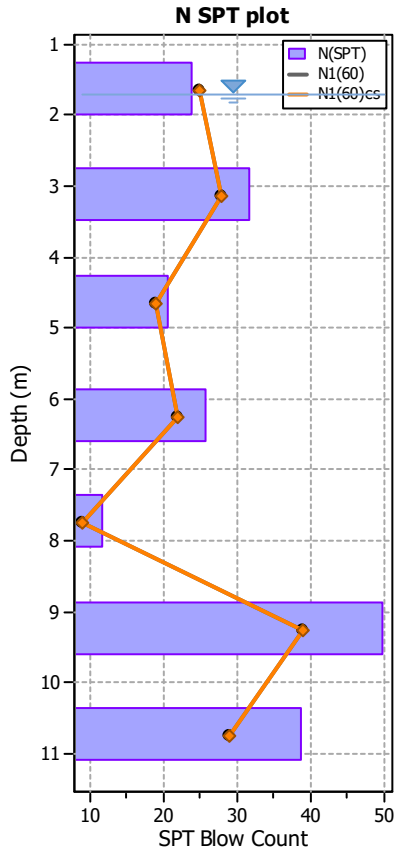
Project title : Liquefaction Assessment - 511185

Location : 518 Rangiora Woodend Road & 4 Golf Links Road

Borehole Name : BH03_ULS

:: Input parameters and analysis properties ::

Analysis method:	Idriss & Boulanger 2014	G.W.T. (in-situ):	2.20	EQ site conditions:	Same as initial
Fines correction method:	Idriss & Boulanger 2014	G.W.T. (earthq.):	1.70		
Sampling method:	Standard Sample	Earthquake magnitude M_w :	7.50		
Borehole diameter:	65 mm to 11 5mm	Peak ground acceleration:	0.35		
Rod length:	1.50	SPT results rounding mode:	Nearest		
Hammer energy ratio:	0.82				



:: Cyclic Stress Ratio fully adjusted (CSR*) numeric results ::												
No	Depth (m)	Weight (kN/m ³)	u ₀ (kPa)	σ _v (kPa)	Ext. Load (kPa)	σ' _v (kPa)	r _d	CSR	K _σ	MSF _{max}	MSF	CSR*
1	1.65	20.00	0.00	33.00	0.00	33.00	0.99	0.226	1.10	1.72	1.00	2.000
2	3.15	20.00	14.22	63.00	0.00	48.78	0.98	0.288	1.10	1.88	1.00	0.262
3	4.65	20.00	28.94	93.00	0.00	64.06	0.96	0.319	1.06	1.45	1.00	0.301
4	6.25	20.00	44.64	125.00	0.00	80.36	0.95	0.335	1.03	1.58	1.00	0.324
5	7.75	20.00	59.35	155.00	0.00	95.65	0.93	0.342	1.00	1.17	1.00	0.340
6	9.25	20.00	74.07	185.00	0.00	110.93	0.91	0.344	0.97	2.20	1.00	0.354
7	10.75	20.00	88.78	215.00	0.00	126.22	0.89	0.343	0.96	1.94	1.00	2.000

Abbreviations

Depth:	Depth from free surface where SPT was performed (m) during eq.
u ₀ :	Water pressure at test point (kPa) during eq.
σ _v :	Total overburden pressure at test point (kPa) during eq.
σ' _v :	Effective overburden pressure based on GWT during earthquake (kPa) during eq.
r _d :	Nonlinear shear mass factor
CSR:	Cyclic Stress Ratio
MSF:	Effective overburden stress factor
K _σ :	Magnitude Scaling Factor
CSR*:	CSR fully adjusted

:: Cyclic Resistance Ratio (CRR) numeric results ::																
No	Depth (m)	Fines %	u ₀ (kPa)	σ _v (kPa)	σ' _v (kPa)	N _{SPT}	C _N	C _R	C _B	C _S	C _E	N ₁₍₆₀₎	Δ(N ₁) ₆₀	N _{1(60),cs}	CRR _{7.5}	F.S.
1	1.65	3.43	0.00	33.00	33.00	24	1.57	0.80	1.00	1.00	0.82	25	0.00	25	4.000	2.00
2	3.15	7.04	9.32	63.00	53.68	32	1.27	0.85	1.00	1.00	0.82	28	0.14	28	0.384	1.46
3	4.65	0.00	24.03	93.00	68.97	21	1.19	0.95	1.00	1.00	0.82	19	0.00	19	0.194	0.65
4	6.25	0.00	39.73	125.00	85.27	26	1.08	0.95	1.00	1.00	0.82	22	0.00	22	0.233	0.72
5	7.75	0.00	54.45	155.00	100.55	12	1.00	0.95	1.00	1.00	0.82	9	0.00	9	0.111	0.33
6	9.25	0.00	69.16	185.00	115.84	50	0.96	1.00	1.00	1.00	0.82	39	0.00	39	3.025	2.00
7	10.75	0.00	83.88	215.00	131.12	39	0.91	1.00	1.00	1.00	0.82	29	0.00	29	4.000	2.00

Abbreviations

Depth:	Depth from free surface where SPT was performed (m)	C _B :	Borehole diameter factor
Weight:	Soil unit weight from previous test point to current (kN/m ³)	C _R :	Rod length factor
u ₀ :	Water pressure at test point (kPa)	C _S :	Sampling method factor
σ _v :	Total overburden pressure at test point (kPa)	N ₁₍₆₀₎ :	Number of blows corrected for 60% energy
σ' _v :	Effective overburden pressure based on in situ GWT (kPa)	ΔN _{1(60),cs} :	Fines correction
N _{SPT} :	Number of blows count in the field (blows/30 cm)	N _{1(60),cs} :	Number of blows corrected for 60% energy and fines
C _N :	Overburden pressure factor	CRR _{7.5} :	Cyclic Resistance Ratio for M _w 7.50
C _E :	Energy ratio factor	F.S.:	Factor of safety against liquefaction

SPT BASED LIQUEFACTION ANALYSIS REPORT

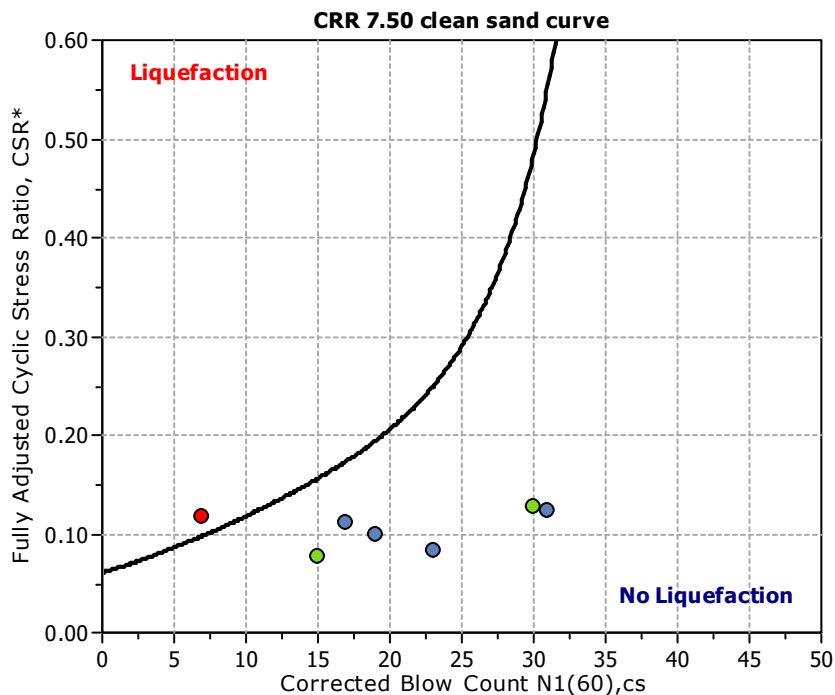
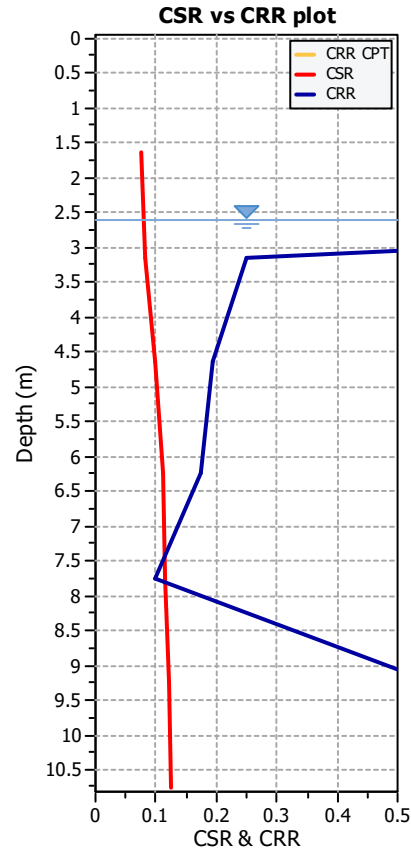
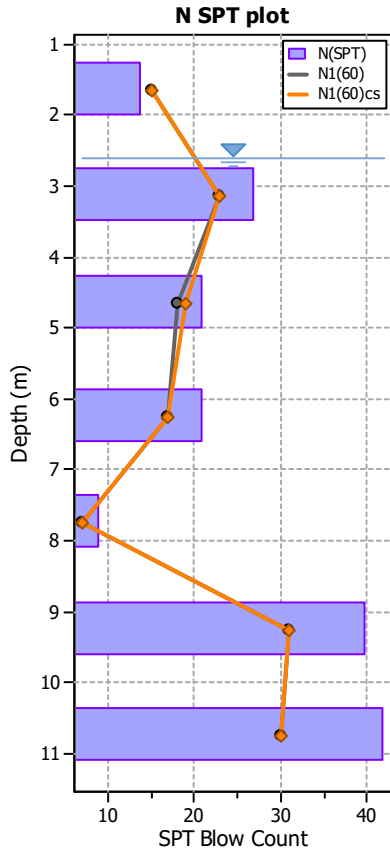
Project title : Liquefaction Assessment - 511185

Location : 518 Rangiora Woodend Road & 4 Golf Links Road

Borehole Name : BH04_SLS1

:: Input parameters and analysis properties ::

Analysis method:	Idriss & Boulanger 2014	G.W.T. (in-situ):	3.10	EQ site conditions:	Same as initial
Fines correction method:	Idriss & Boulanger 2014	G.W.T. (earthq.):	2.60		
Sampling method:	Standard Sample	Earthquake magnitude M_w :	7.50		
Borehole diameter:	65 mm to 115 mm	Peak ground acceleration:	0.13		
Rod length:	1.50	SPT results rounding mode:	Nearest		
Hammer energy ratio:	0.82				



:: Cyclic Stress Ratio fully adjusted (CSR*) numeric results ::												
No	Depth (m)	Weight (kN/m ³)	u ₀ (kPa)	σ _v (kPa)	Ext. Load (kPa)	σ' _v (kPa)	r _d	CSR	K _σ	MSF _{max}	MSF	CSR*
1	1.65	20.00	0.00	33.00	0.00	33.00	0.99	0.084	1.10	1.32	1.00	2.000
2	3.15	20.00	5.40	63.00	0.00	57.60	0.98	0.091	1.08	1.62	1.00	0.084
3	4.65	20.00	20.11	93.00	0.00	72.89	0.96	0.104	1.04	1.45	1.00	0.100
4	6.25	20.00	35.81	125.00	0.00	89.19	0.95	0.112	1.01	1.38	1.00	0.110
5	7.75	20.00	50.52	155.00	0.00	104.48	0.93	0.116	1.00	1.14	1.00	0.117
6	9.25	20.00	65.24	185.00	0.00	119.76	0.91	0.118	0.96	2.06	1.00	0.123
7	10.75	20.00	79.95	215.00	0.00	135.05	0.89	0.119	0.94	2.00	1.00	2.000

Abbreviations

- Depth: Depth from free surface where SPT was performed (m) during eq.
- u₀: Water pressure at test point (kPa) during eq.
- σ_v: Total overburden pressure at test point (kPa) during eq.
- σ'_v: Effective overburden pressure based on GWT during earthquake (kPa) during eq.
- r_d: Nonlinear shear mass factor
- CSR: Cyclic Stress Ratio
- MSF: Effective overburden stress factor
- K_σ: Magnitude Scaling Factor
- CSR*: CSR fully adjusted

:: Cyclic Resistance Ratio (CRR) numeric results ::																
No	Depth (m)	Fines %	u ₀ (kPa)	σ _v (kPa)	σ' _v (kPa)	N _{SPT}	C _N	C _R	C _B	C _S	C _E	N ₁₍₆₀₎	Δ(N ₁) ₆₀	N _{1(60),cs}	CRR _{7.5}	F.S.
1	1.65	4.67	0.00	33.00	33.00	14	1.70	0.80	1.00	1.00	0.82	15	0.00	15	4.000	2.00
2	3.15	0.96	0.49	63.00	62.51	27	1.22	0.85	1.00	1.00	0.82	23	0.00	23	0.249	2.00
3	4.65	9.20	15.21	93.00	77.79	21	1.13	0.95	1.00	1.00	0.82	18	0.80	19	0.194	1.95
4	6.25	0.00	30.90	125.00	94.10	21	1.04	0.95	1.00	1.00	0.82	17	0.00	17	0.174	1.58
5	7.75	0.00	45.62	155.00	109.38	9	0.96	0.95	1.00	1.00	0.82	7	0.00	7	0.098	0.84
6	9.25	0.00	60.33	185.00	124.67	40	0.93	1.00	1.00	1.00	0.82	31	0.00	31	0.555	2.00
7	10.75	0.00	75.05	215.00	139.95	42	0.89	1.00	1.00	1.00	0.82	30	0.00	30	4.000	2.00

Abbreviations

- Depth: Depth from free surface where SPT was performed (m)
- Weight: Soil unit weight from previous test point to current (kN/m³)
- u₀: Water pressure at test point (kPa)
- σ_v: Total overburden pressure at test point (kPa)
- σ'_v: Effective overburden pressure based on in situ GWT (kPa)
- N_{SPT}: Number of blows count in the field (blows/30 cm)
- C_N: Overburden pressure factor
- C_E: Energy ratio factor
- C_B: Borehole diameter factor
- C_R: Rod length factor
- C_S: Sampling method factor
- N₁₍₆₀₎: Number of blows corrected for 60% energy
- ΔN_{1(60),cs}: Fines correction
- N_{1(60),cs}: Number of blows corrected for 60% energy and fines
- CRR_{7.5}: Cyclic Resistance Ratio for M_w 7.50
- F.S.: Factor of safety against liquefaction

SPT BASED LIQUEFACTION ANALYSIS REPORT

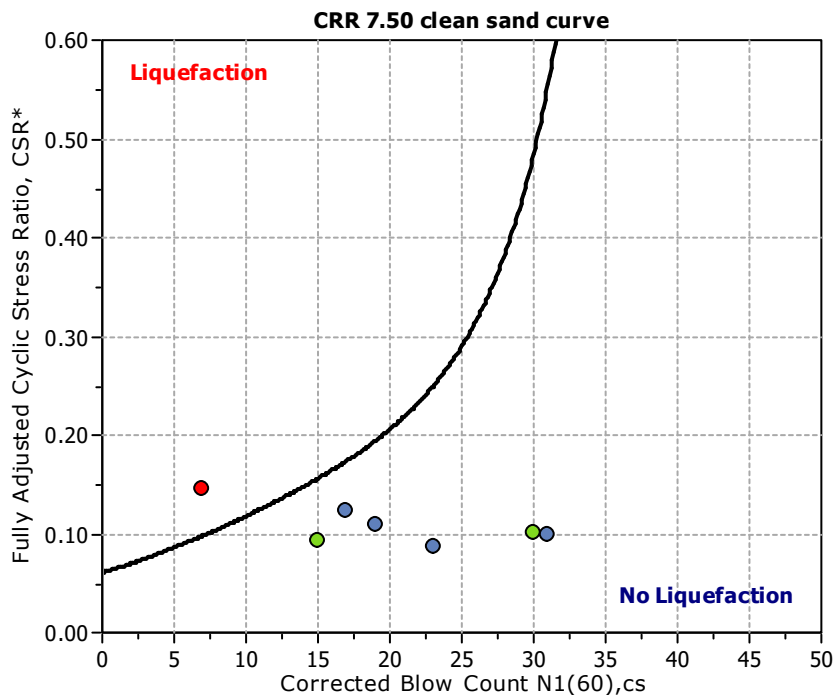
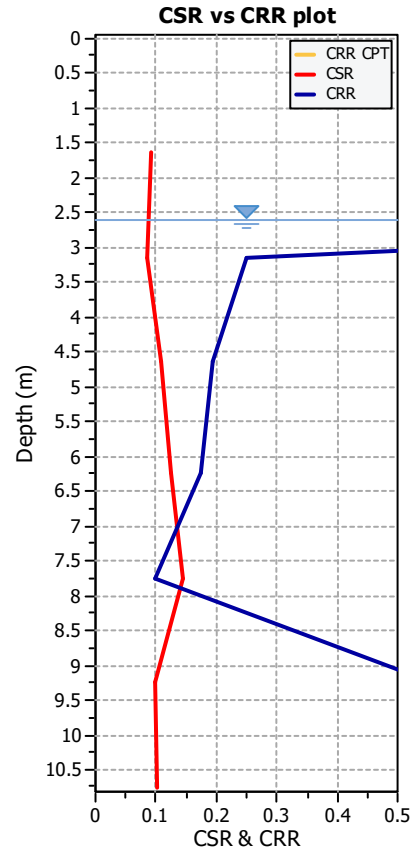
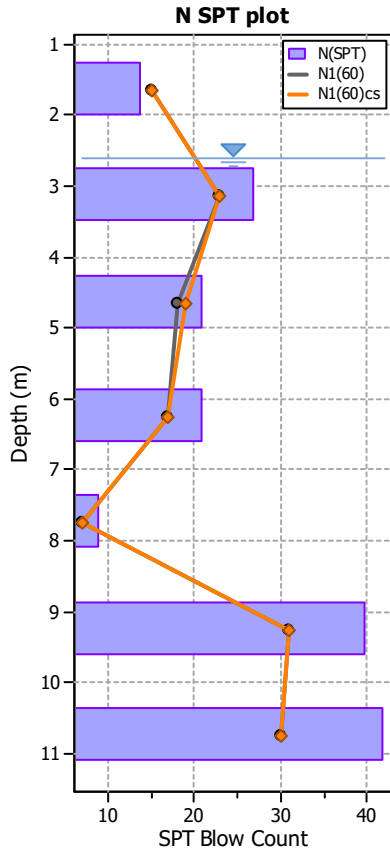
Project title : Liquefaction Assessment - 511185

Location : 518 Rangiora Woodend Road & 4 Golf Links Road

Borehole Name : BH04_SLS2

:: Input parameters and analysis properties ::

Analysis method:	Idriss & Boulanger 2014	G.W.T. (in-situ):	3.10	EQ site conditions:	Same as initial
Fines correction method:	Idriss & Boulanger 2014	G.W.T. (earthq.):	2.60		
Sampling method:	Standard Sample	Earthquake magnitude M_w :	6.00		
Borehole diameter:	65 mm to 115 mm	Peak ground acceleration:	0.19		
Rod length:	1.50	SPT results rounding mode:	Nearest		
Hammer energy ratio:	0.82				



:: Cyclic Stress Ratio fully adjusted (CSR*) numeric results ::												
No	Depth (m)	Weight (kN/m ³)	u ₀ (kPa)	σ _v (kPa)	Ext. Load (kPa)	σ' _v (kPa)	r _d	CSR	K _σ	MSF _{max}	MSF	CSR*
1	1.65	20.00	0.00	33.00	0.00	33.00	0.98	0.121	1.10	1.32	1.48	2.000
2	3.15	20.00	5.40	63.00	0.00	57.60	0.96	0.129	1.08	1.62	1.48	0.087
3	4.65	20.00	20.11	93.00	0.00	72.89	0.93	0.146	1.04	1.45	1.48	0.110
4	6.25	20.00	35.81	125.00	0.00	89.19	0.89	0.154	1.01	1.38	1.48	0.123
5	7.75	20.00	50.52	155.00	0.00	104.48	0.85	0.157	1.00	1.14	1.48	0.145
6	9.25	20.00	65.24	185.00	0.00	119.76	0.82	0.156	0.96	2.06	1.48	0.099
7	10.75	20.00	79.95	215.00	0.00	135.05	0.78	0.153	0.94	2.00	1.48	2.000

Abbreviations

- Depth: Depth from free surface where SPT was performed (m) during eq.
- u₀: Water pressure at test point (kPa) during eq.
- σ_v: Total overburden pressure at test point (kPa) during eq.
- σ'_v: Effective overburden pressure based on GWT during earthquake (kPa) during eq.
- r_d: Nonlinear shear mass factor
- CSR: Cyclic Stress Ratio
- MSF: Effective overburden stress factor
- K_σ: Magnitude Scaling Factor
- CSR*: CSR fully adjusted

:: Cyclic Resistance Ratio (CRR) numeric results ::																
No	Depth (m)	Fines %	u ₀ (kPa)	σ _v (kPa)	σ' _v (kPa)	N _{SPT}	C _N	C _R	C _B	C _S	C _E	N ₁₍₆₀₎	Δ(N ₁) ₆₀	N _{1(60),cs}	CRR _{7.5}	F.S.
1	1.65	4.67	0.00	33.00	33.00	14	1.70	0.80	1.00	1.00	0.82	15	0.00	15	4.000	2.00
2	3.15	0.96	0.49	63.00	62.51	27	1.22	0.85	1.00	1.00	0.82	23	0.00	23	0.249	2.00
3	4.65	9.20	15.21	93.00	77.79	21	1.13	0.95	1.00	1.00	0.82	18	0.80	19	0.194	1.77
4	6.25	0.00	30.90	125.00	94.10	21	1.04	0.95	1.00	1.00	0.82	17	0.00	17	0.174	1.41
5	7.75	0.00	45.62	155.00	109.38	9	0.96	0.95	1.00	1.00	0.82	7	0.00	7	0.098	0.68
6	9.25	0.00	60.33	185.00	124.67	40	0.93	1.00	1.00	1.00	0.82	31	0.00	31	0.555	2.00
7	10.75	0.00	75.05	215.00	139.95	42	0.89	1.00	1.00	1.00	0.82	30	0.00	30	4.000	2.00

Abbreviations

- Depth: Depth from free surface where SPT was performed (m)
- Weight: Soil unit weight from previous test point to current (kN/m³)
- u₀: Water pressure at test point (kPa)
- σ_v: Total overburden pressure at test point (kPa)
- σ'_v: Effective overburden pressure based on in situ GWT (kPa)
- N_{SPT}: Number of blows count in the field (blows/30 cm)
- C_N: Overburden pressure factor
- C_E: Energy ratio factor
- C_B: Borehole diameter factor
- C_R: Rod length factor
- C_S: Sampling method factor
- N₁₍₆₀₎: Number of blows corrected for 60% energy
- ΔN_{1(60),cs}: Fines correction
- N_{1(60),cs}: Number of blows corrected for 60% energy and fines
- CRR_{7.5}: Cyclic Resistance Ratio for M_w 7.50
- F.S.: Factor of safety against liquefaction

SPT BASED LIQUEFACTION ANALYSIS REPORT

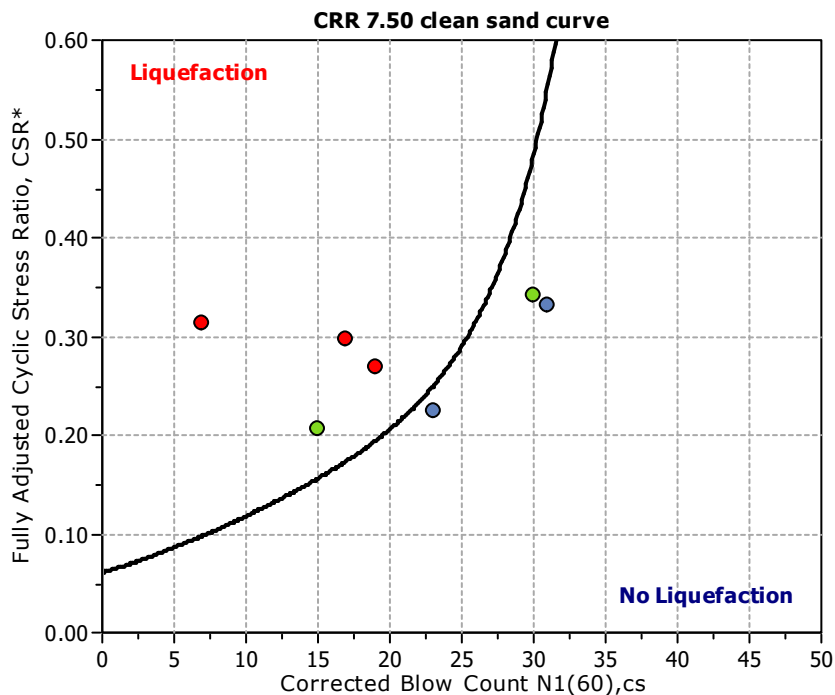
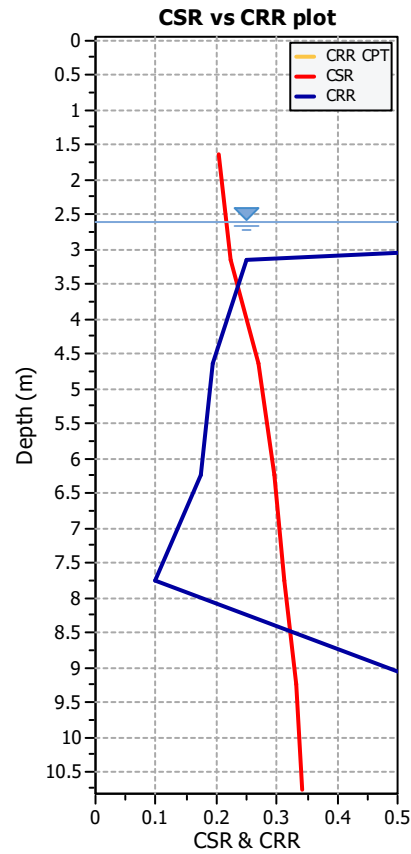
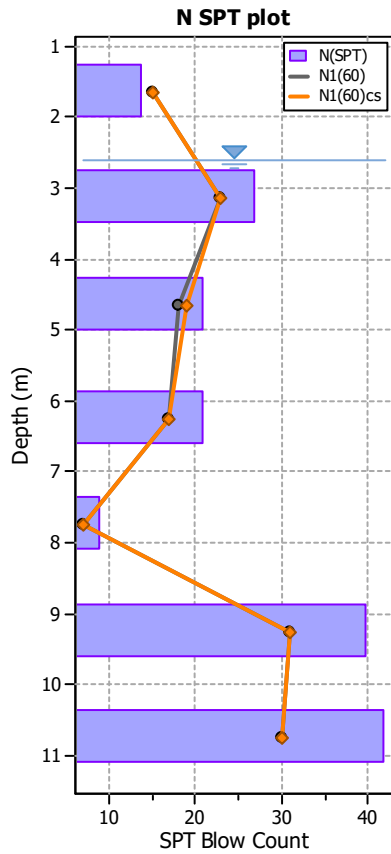
Project title : Liquefaction Assessment - 511185

Location : 518 Rangiora Woodend Road & 4 Golf Links Road

Borehole Name : BH04_ULS

:: Input parameters and analysis properties ::

Analysis method:	Idriss & Boulanger 2014	G.W.T. (in-situ):	3.10	EQ site conditions:	Same as initial
Fines correction method:	Idriss & Boulanger 2014	G.W.T. (earthq.):	2.60		
Sampling method:	Standard Sample	Earthquake magnitude M_w :	7.50		
Borehole diameter:	65 mm to 115 mm	Peak ground acceleration:	0.35		
Rod length:	1.50	SPT results rounding mode:	Nearest		
Hammer energy ratio:	0.82				



:: Cyclic Stress Ratio fully adjusted (CSR*) numeric results ::												
No	Depth (m)	Weight (kN/m ³)	u ₀ (kPa)	σ _v (kPa)	Ext. Load (kPa)	σ' _v (kPa)	r _d	CSR	K _σ	MSF _{max}	MSF	CSR*
1	1.65	20.00	0.00	33.00	0.00	33.00	0.99	0.226	1.10	1.32	1.00	2.000
2	3.15	20.00	5.40	63.00	0.00	57.60	0.98	0.244	1.08	1.62	1.00	0.225
3	4.65	20.00	20.11	93.00	0.00	72.89	0.96	0.280	1.04	1.45	1.00	0.269
4	6.25	20.00	35.81	125.00	0.00	89.19	0.95	0.302	1.01	1.38	1.00	0.297
5	7.75	20.00	50.52	155.00	0.00	104.48	0.93	0.313	1.00	1.14	1.00	0.314
6	9.25	20.00	65.24	185.00	0.00	119.76	0.91	0.319	0.96	2.06	1.00	0.331
7	10.75	20.00	79.95	215.00	0.00	135.05	0.89	0.321	0.94	2.00	1.00	2.000

Abbreviations

Depth:	Depth from free surface where SPT was performed (m) during eq.
u ₀ :	Water pressure at test point (kPa) during eq.
σ _v :	Total overburden pressure at test point (kPa) during eq.
σ' _v :	Effective overburden pressure based on GWT during earthquake (kPa) during eq.
r _d :	Nonlinear shear mass factor
CSR:	Cyclic Stress Ratio
MSF:	Effective overburden stress factor
K _σ :	Magnitude Scaling Factor
CSR*:	CSR fully adjusted

:: Cyclic Resistance Ratio (CRR) numeric results ::																
No	Depth (m)	Fines %	u ₀ (kPa)	σ _v (kPa)	σ' _v (kPa)	N _{SPT}	C _N	C _R	C _B	C _S	C _E	N ₁₍₆₀₎	Δ(N ₁) ₆₀	N _{1(60),cs}	CRR _{7.5}	F.S.
1	1.65	4.67	0.00	33.00	33.00	14	1.70	0.80	1.00	1.00	0.82	15	0.00	15	4.000	2.00
2	3.15	0.96	0.49	63.00	62.51	27	1.22	0.85	1.00	1.00	0.82	23	0.00	23	0.249	1.11
3	4.65	9.20	15.21	93.00	77.79	21	1.13	0.95	1.00	1.00	0.82	18	0.80	19	0.194	0.72
4	6.25	0.00	30.90	125.00	94.10	21	1.04	0.95	1.00	1.00	0.82	17	0.00	17	0.174	0.59
5	7.75	0.00	45.62	155.00	109.38	9	0.96	0.95	1.00	1.00	0.82	7	0.00	7	0.098	0.31
6	9.25	0.00	60.33	185.00	124.67	40	0.93	1.00	1.00	1.00	0.82	31	0.00	31	0.555	1.68
7	10.75	0.00	75.05	215.00	139.95	42	0.89	1.00	1.00	1.00	0.82	30	0.00	30	4.000	2.00

Abbreviations

Depth:	Depth from free surface where SPT was performed (m)	C _B :	Borehole diameter factor
Weight:	Soil unit weight from previous test point to current (kN/m ³)	C _R :	Rod length factor
u ₀ :	Water pressure at test point (kPa)	C _S :	Sampling method factor
σ _v :	Total overburden pressure at test point (kPa)	N ₁₍₆₀₎ :	Number of blows corrected for 60% energy
σ' _v :	Effective overburden pressure based on in situ GWT (kPa)	ΔN _{1(60),cs} :	Fines correction
N _{SPT} :	Number of blows count in the field (blows/30 cm)	N _{1(60),cs} :	Number of blows corrected for 60% energy and fines
C _N :	Overburden pressure factor	CRR _{7.5} :	Cyclic Resistance Ratio for M _w 7.50
C _E :	Energy ratio factor	F.S.:	Factor of safety against liquefaction

SPT BASED LIQUEFACTION ANALYSIS REPORT

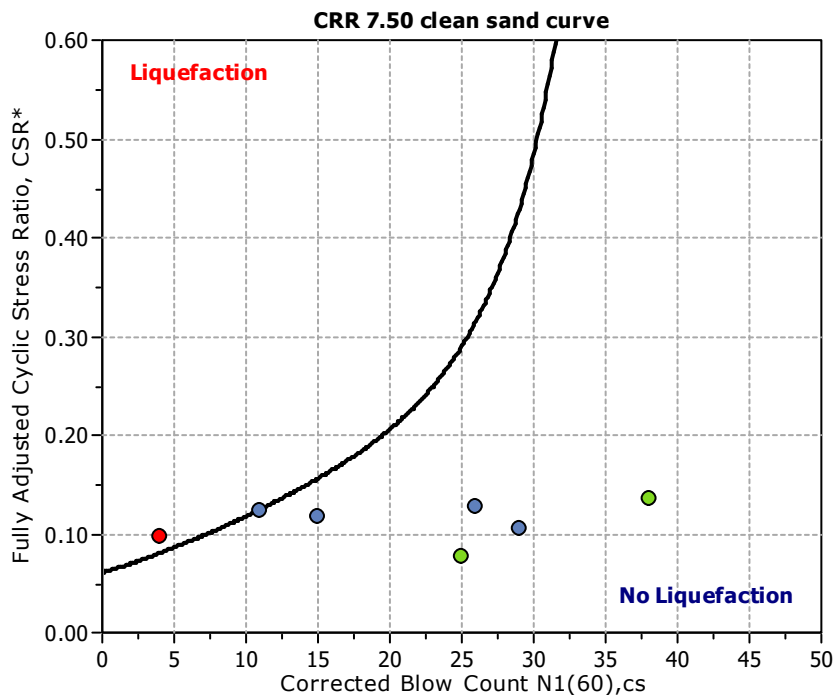
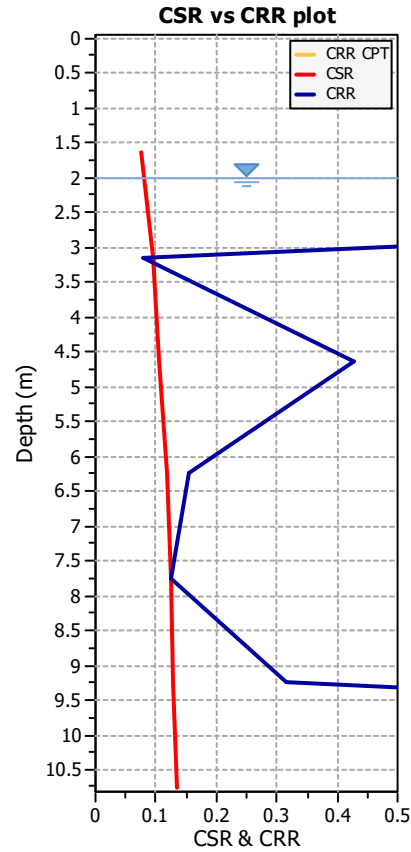
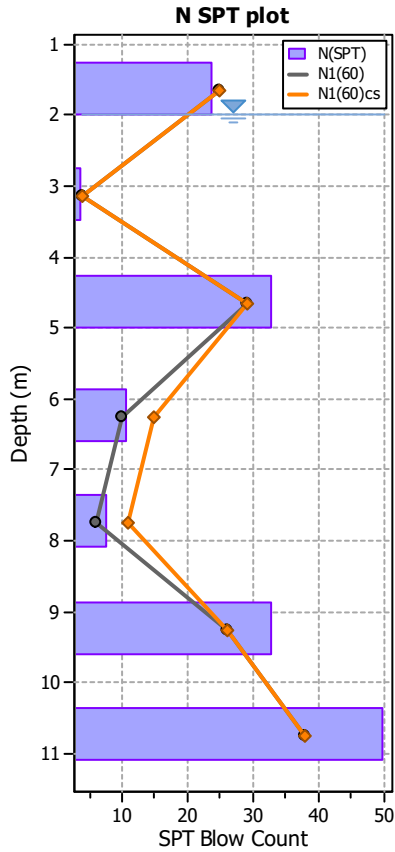
Project title : Liquefaction Assessment - 511185

Location : 518 Rangiora Woodend Road & 4 Golf Links Road

Borehole Name : BH05_SLS1

:: Input parameters and analysis properties ::

Analysis method:	Idriss & Boulanger 2014	G.W.T. (in-situ):	2.50	EQ site conditions:	Same as initial
Fines correction method:	Idriss & Boulanger 2014	G.W.T. (earthq.):	2.00		
Sampling method:	Standard Sample	Earthquake magnitude M_w :	7.50		
Borehole diameter:	65 mm to 115 mm	Peak ground acceleration:	0.13		
Rod length:	1.50	SPT results rounding mode:	Nearest		
Hammer energy ratio:	0.82				



:: Cyclic Stress Ratio fully adjusted (CSR*) numeric results ::												
No	Depth (m)	Weight (kN/m ³)	u ₀ (kPa)	σ _v (kPa)	Ext. Load (kPa)	σ' _v (kPa)	r _d	CSR	K _σ	MSF _{max}	MSF	CSR*
1	1.65	20.00	0.00	33.00	0.00	33.00	0.99	0.084	1.10	1.72	1.00	2.000
2	3.15	20.00	11.28	63.00	0.00	51.72	0.98	0.101	1.05	1.11	1.00	0.096
3	4.65	20.00	26.00	93.00	0.00	67.00	0.96	0.113	1.08	1.94	1.00	0.105
4	6.25	19.00	41.69	123.40	0.00	81.71	0.95	0.121	1.02	1.32	1.00	0.118
5	7.75	19.00	56.41	151.90	0.00	95.49	0.93	0.125	1.01	1.21	1.00	0.124
6	9.25	20.00	71.12	181.90	0.00	110.78	0.91	0.126	0.98	1.77	1.00	0.128
7	10.75	20.00	85.84	211.90	0.00	126.06	0.89	0.126	0.93	2.20	1.00	2.000

Abbreviations

- Depth: Depth from free surface where SPT was performed (m) during eq.
- u₀: Water pressure at test point (kPa) during eq.
- σ_v: Total overburden pressure at test point (kPa) during eq.
- σ'_v: Effective overburden pressure based on GWT during earthquake (kPa) during eq.
- r_d: Nonlinear shear mass factor
- CSR: Cyclic Stress Ratio
- MSF: Effective overburden stress factor
- K_σ: Magnitude Scaling Factor
- CSR*: CSR fully adjusted

:: Cyclic Resistance Ratio (CRR) numeric results ::																
No	Depth (m)	Fines %	u ₀ (kPa)	σ _v (kPa)	σ' _v (kPa)	N _{SPT}	C _N	C _R	C _B	C _S	C _E	N ₁₍₆₀₎	Δ(N ₁) ₆₀	N _{1(60),cs}	CRR _{7.5}	F.S.
1	1.65	1.32	0.00	33.00	33.00	24	1.57	0.80	1.00	1.00	0.82	25	0.00	25	4.000	2.00
2	3.15	0.00	6.38	63.00	56.62	4	1.44	0.85	1.00	1.00	0.82	4	0.00	4	0.080	0.84
3	4.65	0.00	21.09	93.00	71.91	33	1.13	0.95	1.00	1.00	0.82	29	0.00	29	0.429	2.00
4	6.25	28.50	36.79	123.40	86.61	11	1.08	0.95	1.00	1.00	0.82	10	5.30	15	0.156	1.32
5	7.75	27.60	51.50	151.90	100.40	8	1.00	0.95	1.00	1.00	0.82	6	5.25	11	0.125	1.01
6	9.25	0.00	66.22	181.90	115.68	33	0.95	1.00	1.00	1.00	0.82	26	0.00	26	0.316	2.00
7	10.75	0.00	80.93	211.90	130.97	50	0.92	1.00	1.00	1.00	0.82	38	0.00	38	4.000	2.00

Abbreviations

- Depth: Depth from free surface where SPT was performed (m)
- Weight: Soil unit weight from previous test point to current (kN/m³)
- u₀: Water pressure at test point (kPa)
- σ_v: Total overburden pressure at test point (kPa)
- σ'_v: Effective overburden pressure based on in situ GWT (kPa)
- N_{SPT}: Number of blows count in the field (blows/30 cm)
- C_N: Overburden pressure factor
- C_E: Energy ratio factor
- C_B: Borehole diameter factor
- C_R: Rod length factor
- C_S: Sampling method factor
- N₁₍₆₀₎: Number of blows corrected for 60% energy
- ΔN_{1(60),cs}: Fines correction
- N_{1(60),cs}: Number of blows corrected for 60% energy and fines
- CRR_{7.5}: Cyclic Resistance Ratio for M_w 7.50
- F.S.: Factor of safety against liquefaction

SPT BASED LIQUEFACTION ANALYSIS REPORT

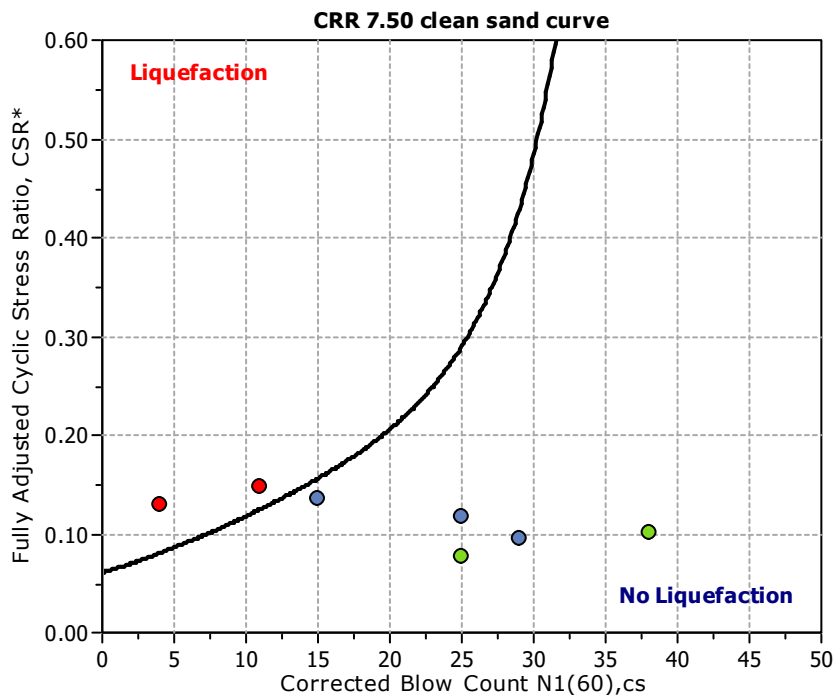
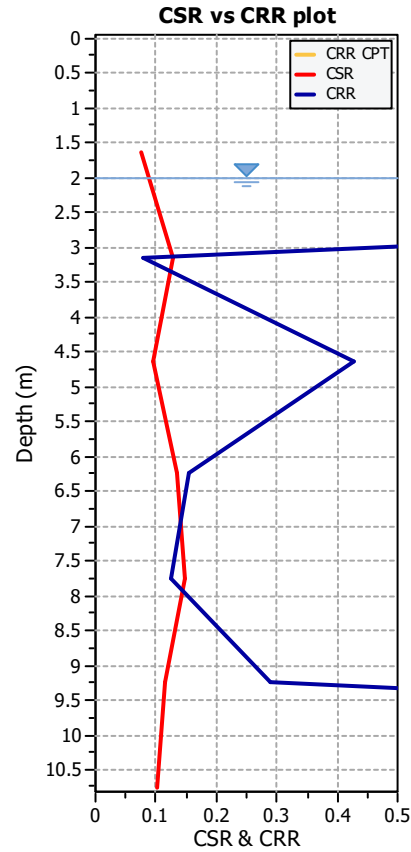
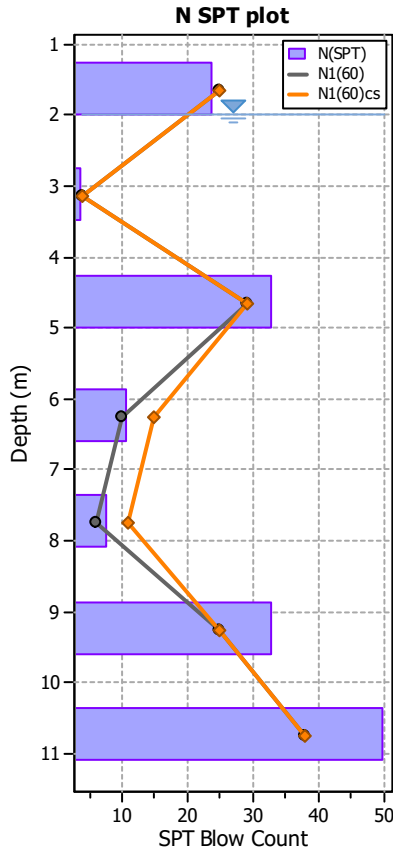
Project title : Liquefaction Assessment - 511185

Location : 518 Rangiora Woodend Road & 4 Golf Links Road

Borehole Name : BH05_SLS2

:: Input parameters and analysis properties ::

Analysis method:	Idriss & Boulanger 2014	G.W.T. (in-situ):	2.50	EQ site conditions:	Same as initial
Fines correction method:	Idriss & Boulanger 2014	G.W.T. (earthq.):	2.00		
Sampling method:	Standard Sample	Earthquake magnitude M_w :	6.00		
Borehole diameter:	65 mm to 115 mm	Peak ground acceleration:	0.19		
Rod length:	1.50	SPT results rounding mode:	Nearest		
Hammer energy ratio:	0.82				



:: Cyclic Stress Ratio fully adjusted (CSR*) numeric results ::

No	Depth (m)	Weight (kN/m ³)	u ₀ (kPa)	σ _v (kPa)	Ext. Load (kPa)	σ' _v (kPa)	r _d	CSR	K _σ	MSF _{max}	MSF	CSR*
1	1.65	20.00	0.00	33.00	0.00	33.00	0.98	0.121	1.10	1.72	1.48	2.000
2	3.15	20.00	11.28	63.00	0.00	51.72	0.96	0.144	1.05	1.11	1.48	0.129
3	4.65	20.00	26.00	93.00	0.00	67.00	0.93	0.159	1.08	1.94	1.48	0.094
4	6.25	20.00	41.69	125.00	0.00	83.31	0.89	0.165	1.02	1.32	1.48	0.136
5	7.75	20.00	56.41	155.00	0.00	98.59	0.85	0.166	1.00	1.21	1.48	0.147
6	9.25	20.00	71.12	185.00	0.00	113.88	0.82	0.164	0.98	1.72	1.48	0.117
7	10.75	20.00	85.84	215.00	0.00	129.16	0.78	0.160	0.93	2.20	1.48	2.000

Abbreviations

- Depth: Depth from free surface where SPT was performed (m) during eq.
- u₀: Water pressure at test point (kPa) during eq.
- σ_v: Total overburden pressure at test point (kPa) during eq.
- σ'_v: Effective overburden pressure based on GWT during earthquake (kPa) during eq.
- r_d: Nonlinear shear mass factor
- CSR: Cyclic Stress Ratio
- MSF: Effective overburden stress factor
- K_σ: Magnitude Scaling Factor
- CSR*: CSR fully adjusted

:: Cyclic Resistance Ratio (CRR) numeric results ::

No	Depth (m)	Fines %	u ₀ (kPa)	σ _v (kPa)	σ' _v (kPa)	N _{SPT}	C _N	C _R	C _B	C _S	C _E	N ₁₍₆₀₎	Δ(N ₁) ₆₀	N _{1(60),cs}	CRR _{7.5}	F.S.
1	1.65	1.32	0.00	33.00	33.00	24	1.57	0.80	1.00	1.00	0.82	25	0.00	25	4.000	2.00
2	3.15	0.00	6.38	63.00	56.62	4	1.44	0.85	1.00	1.00	0.82	4	0.00	4	0.080	0.62
3	4.65	0.00	21.09	93.00	71.91	33	1.13	0.95	1.00	1.00	0.82	29	0.00	29	0.429	2.00
4	6.25	28.50	36.79	125.00	88.21	11	1.07	0.95	1.00	1.00	0.82	10	5.30	15	0.156	1.15
5	7.75	27.60	51.50	155.00	103.50	8	0.99	0.95	1.00	1.00	0.82	6	5.25	11	0.125	0.85
6	9.25	0.00	66.22	185.00	118.78	33	0.94	1.00	1.00	1.00	0.82	25	0.00	25	0.290	2.00
7	10.75	0.00	80.93	215.00	134.07	50	0.92	1.00	1.00	1.00	0.82	38	0.00	38	4.000	2.00

Abbreviations

- Depth: Depth from free surface where SPT was performed (m)
- Weight: Soil unit weight from previous test point to current (kN/m³)
- u₀: Water pressure at test point (kPa)
- σ_v: Total overburden pressure at test point (kPa)
- σ'_v: Effective overburden pressure based on in situ GWT (kPa)
- N_{SPT}: Number of blows count in the field (blows/30 cm)
- C_N: Overburden pressure factor
- C_E: Energy ratio factor
- C_B: Borehole diameter factor
- C_R: Rod length factor
- C_S: Sampling method factor
- N₁₍₆₀₎: Number of blows corrected for 60% energy
- ΔN_{1(60),cs}: Fines correction
- N_{1(60),cs}: Number of blows corrected for 60% energy and fines
- CRR_{7.5}: Cyclic Resistance Ratio for M_w 7.50
- F.S.: Factor of safety against liquefaction

SPT BASED LIQUEFACTION ANALYSIS REPORT

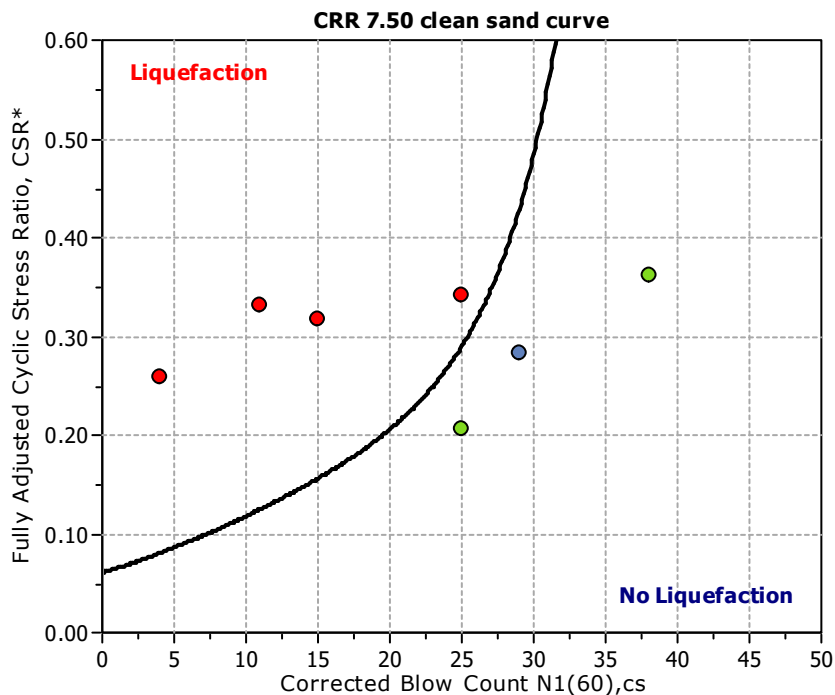
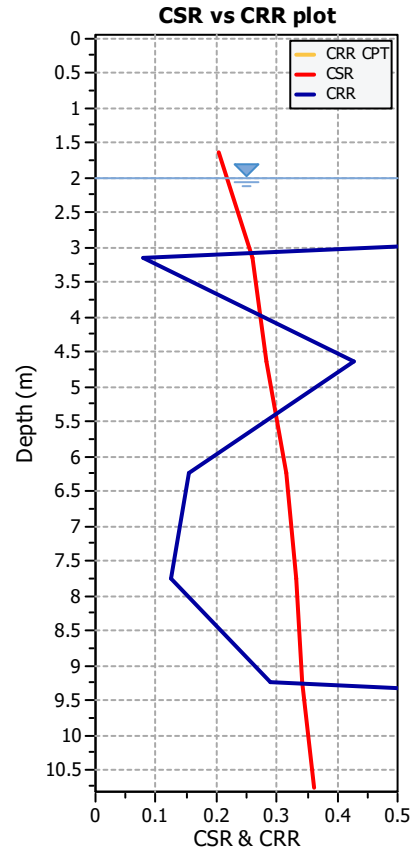
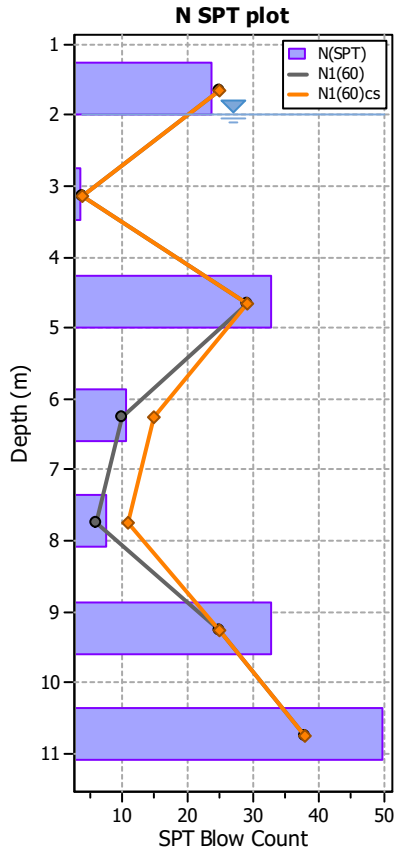
Project title : Liquefaction Assessment - 511185

Location : 518 Rangiora Woodend Road & 4 Golf Links Road

Borehole Name : BH05_ULS

:: Input parameters and analysis properties ::

Analysis method:	Idriss & Boulanger 2014	G.W.T. (in-situ):	2.50	EQ site conditions:	Same as initial
Fines correction method:	Idriss & Boulanger 2014	G.W.T. (earthq.):	2.00		
Sampling method:	Standard Sample	Earthquake magnitude M_w :	7.50		
Borehole diameter:	65 mm to 11 5mm	Peak ground acceleration:	0.35		
Rod length:	1.50	SPT results rounding mode:	Nearest		
Hammer energy ratio:	0.82				



:: Cyclic Stress Ratio fully adjusted (CSR*) numeric results ::												
No	Depth (m)	Weight (kN/m ³)	u ₀ (kPa)	σ _v (kPa)	Ext. Load (kPa)	σ' _v (kPa)	r _d	CSR	K _σ	MSF _{max}	MSF	CSR*
1	1.65	20.00	0.00	33.00	0.00	33.00	0.99	0.226	1.10	1.72	1.00	2.000
2	3.15	20.00	11.28	63.00	0.00	51.72	0.98	0.272	1.05	1.11	1.00	0.259
3	4.65	20.00	26.00	93.00	0.00	67.00	0.96	0.305	1.08	1.94	1.00	0.282
4	6.25	20.00	41.69	125.00	0.00	83.31	0.95	0.323	1.02	1.32	1.00	0.316
5	7.75	20.00	56.41	155.00	0.00	98.59	0.93	0.332	1.00	1.21	1.00	0.331
6	9.25	20.00	71.12	185.00	0.00	113.88	0.91	0.335	0.98	1.72	1.00	0.342
7	10.75	20.00	85.84	215.00	0.00	129.16	0.89	0.335	0.93	2.20	1.00	2.000

Abbreviations

- Depth: Depth from free surface where SPT was performed (m) during eq.
- u₀: Water pressure at test point (kPa) during eq.
- σ_v: Total overburden pressure at test point (kPa) during eq.
- σ'_v: Effective overburden pressure based on GWT during earthquake (kPa) during eq.
- r_d: Nonlinear shear mass factor
- CSR: Cyclic Stress Ratio
- MSF: Effective overburden stress factor
- K_σ: Magnitude Scaling Factor
- CSR*: CSR fully adjusted

:: Cyclic Resistance Ratio (CRR) numeric results ::																
No	Depth (m)	Fines %	u ₀ (kPa)	σ _v (kPa)	σ' _v (kPa)	N _{SPT}	C _N	C _R	C _B	C _S	C _E	N ₁₍₆₀₎	Δ(N ₁) ₆₀	N _{1(60),cs}	CRR _{7.5}	F.S.
1	1.65	1.32	0.00	33.00	33.00	24	1.57	0.80	1.00	1.00	0.82	25	0.00	25	4.000	2.00
2	3.15	0.00	6.38	63.00	56.62	4	1.44	0.85	1.00	1.00	0.82	4	0.00	4	0.080	0.31
3	4.65	0.00	21.09	93.00	71.91	33	1.13	0.95	1.00	1.00	0.82	29	0.00	29	0.429	1.52
4	6.25	28.50	36.79	125.00	88.21	11	1.07	0.95	1.00	1.00	0.82	10	5.30	15	0.156	0.49
5	7.75	27.60	51.50	155.00	103.50	8	0.99	0.95	1.00	1.00	0.82	6	5.25	11	0.125	0.38
6	9.25	0.00	66.22	185.00	118.78	33	0.94	1.00	1.00	1.00	0.82	25	0.00	25	0.290	0.85
7	10.75	0.00	80.93	215.00	134.07	50	0.92	1.00	1.00	1.00	0.82	38	0.00	38	4.000	2.00

Abbreviations

- Depth: Depth from free surface where SPT was performed (m)
- Weight: Soil unit weight from previous test point to current (kN/m³)
- u₀: Water pressure at test point (kPa)
- σ_v: Total overburden pressure at test point (kPa)
- σ'_v: Effective overburden pressure based on in situ GWT (kPa)
- N_{SPT}: Number of blows count in the field (blows/30 cm)
- C_N: Overburden pressure factor
- C_E: Energy ratio factor
- C_B: Borehole diameter factor
- C_R: Rod length factor
- C_S: Sampling method factor
- N₁₍₆₀₎: Number of blows corrected for 60% energy
- ΔN_{1(60),cs}: Fines correction
- N_{1(60),cs}: Number of blows corrected for 60% energy and fines
- CRR_{7.5}: Cyclic Resistance Ratio for M_w 7.50
- F.S.: Factor of safety against liquefaction

SPT BASED LIQUEFACTION ANALYSIS REPORT

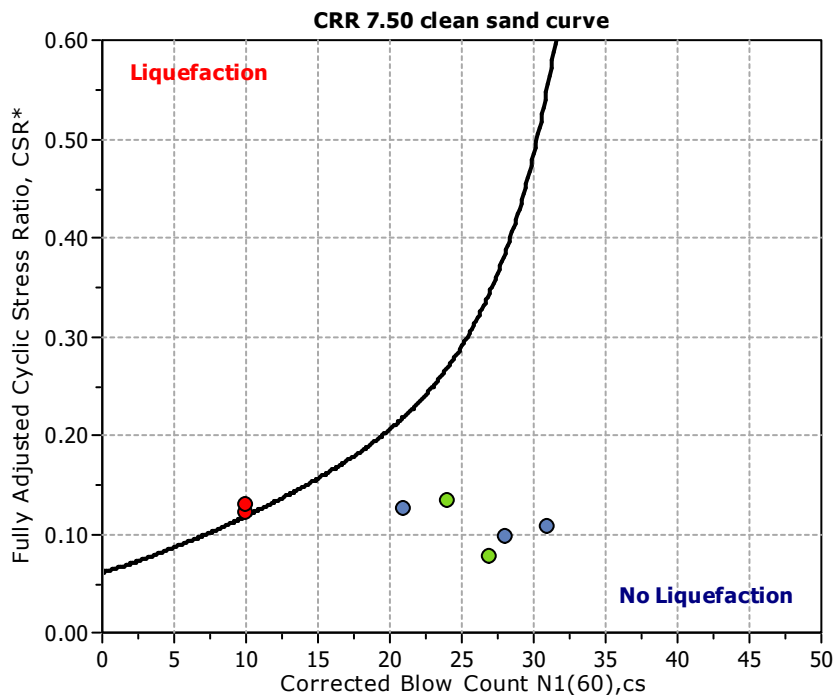
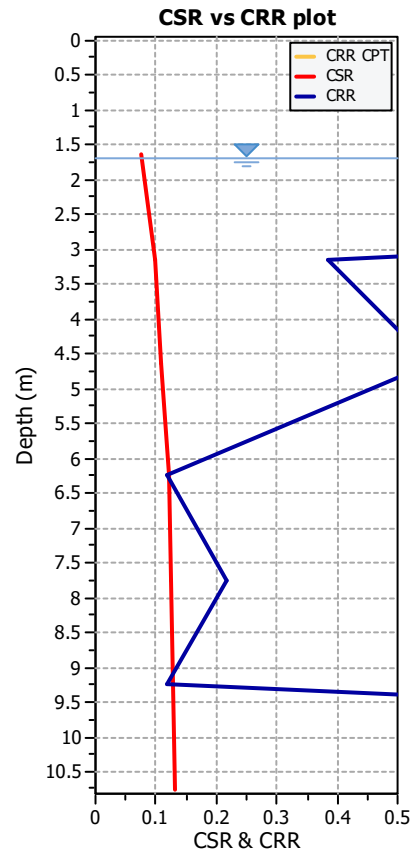
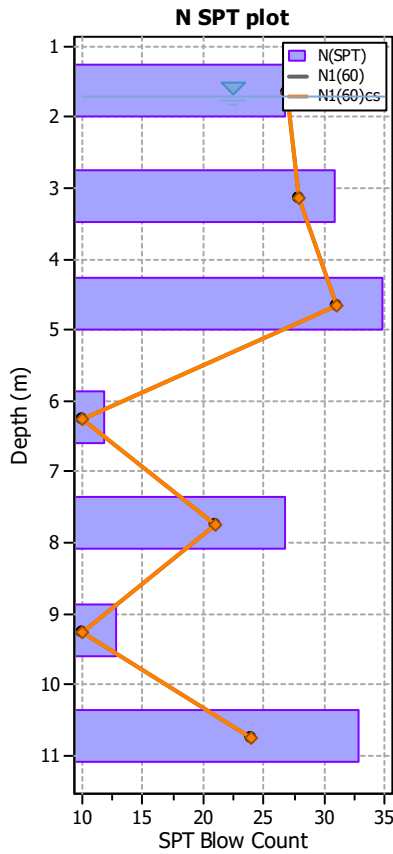
Project title : Liquefaction Assessment - 511185

Location : 518 Rangiora Woodend Road & 4 Golf Links Road

Borehole Name : BH06_SLS1

:: Input parameters and analysis properties ::

Analysis method:	Idriss & Boulanger 2014	G.W.T. (in-situ):	2.20	EQ site conditions:	Same as initial
Fines correction method:	Idriss & Boulanger 2014	G.W.T. (earthq.):	1.70		
Sampling method:	Standard Sample	Earthquake magnitude M_w :	7.50		
Borehole diameter:	65 mm to 115 mm	Peak ground acceleration:	0.13		
Rod length:	1.50	SPT results rounding mode:	Nearest		
Hammer energy ratio:	0.82				



:: Cyclic Stress Ratio fully adjusted (CSR*) numeric results ::												
No	Depth (m)	Weight (kN/m ³)	u ₀ (kPa)	σ _v (kPa)	Ext. Load (kPa)	σ' _v (kPa)	r _d	CSR	K _σ	MSF _{max}	MSF	CSR*
1	1.65	20.00	0.00	33.00	0.00	33.00	0.99	0.084	1.10	1.82	1.00	2.000
2	3.15	20.00	14.22	63.00	0.00	48.78	0.98	0.107	1.10	1.88	1.00	0.097
3	4.65	20.00	28.94	93.00	0.00	64.06	0.96	0.118	1.10	2.06	1.00	0.108
4	6.25	20.00	44.64	125.00	0.00	80.36	0.95	0.124	1.02	1.19	1.00	0.122
5	7.75	20.00	59.35	155.00	0.00	95.65	0.93	0.127	1.01	1.53	1.00	0.126
6	9.25	19.00	74.07	183.50	0.00	109.43	0.91	0.128	0.99	1.19	1.00	0.129
7	10.75	20.00	88.78	213.50	0.00	124.72	0.89	0.128	0.97	1.67	1.00	2.000

Abbreviations

Depth:	Depth from free surface where SPT was performed (m) during eq.
u ₀ :	Water pressure at test point (kPa) during eq.
σ _v :	Total overburden pressure at test point (kPa) during eq.
σ' _v :	Effective overburden pressure based on GWT during earthquake (kPa) during eq.
r _d :	Nonlinear shear mass factor
CSR:	Cyclic Stress Ratio
MSF:	Effective overburden stress factor
K _σ :	Magnitude Scaling Factor
CSR*:	CSR fully adjusted

:: Cyclic Resistance Ratio (CRR) numeric results ::																
No	Depth (m)	Fines %	u ₀ (kPa)	σ _v (kPa)	σ' _v (kPa)	N _{SPT}	C _N	C _R	C _B	C _S	C _E	N ₁₍₆₀₎	Δ(N ₁) ₆₀	N _{1(60),cs}	CRR _{7.5}	F.S.
1	1.65	0.00	0.00	33.00	33.00	27	1.53	0.80	1.00	1.00	0.82	27	0.00	27	4.000	2.00
2	3.15	0.00	9.32	63.00	53.68	31	1.27	0.85	1.00	1.00	0.82	28	0.00	28	0.384	2.00
3	4.65	0.00	24.03	93.00	68.97	35	1.15	0.95	1.00	1.00	0.82	31	0.00	31	0.555	2.00
4	6.25	0.00	39.73	125.00	85.27	12	1.10	0.95	1.00	1.00	0.82	10	0.00	10	0.118	0.97
5	7.75	0.00	54.45	155.00	100.55	27	1.00	0.95	1.00	1.00	0.82	21	0.00	21	0.219	1.74
6	9.25	1.50	69.16	183.50	114.34	13	0.94	1.00	1.00	1.00	0.82	10	0.00	10	0.118	0.91
7	10.75	0.00	83.88	213.50	129.62	33	0.90	1.00	1.00	1.00	0.82	24	0.00	24	4.000	2.00

Abbreviations

Depth:	Depth from free surface where SPT was performed (m)	C _B :	Borehole diameter factor
Weight:	Soil unit weight from previous test point to current (kN/m ³)	C _R :	Rod length factor
u ₀ :	Water pressure at test point (kPa)	C _S :	Sampling method factor
σ _v :	Total overburden pressure at test point (kPa)	N ₁₍₆₀₎ :	Number of blows corrected for 60% energy
σ' _v :	Effective overburden pressure based on in situ GWT (kPa)	ΔN _{1(60),cs} :	Fines correction
N _{SPT} :	Number of blows count in the field (blows/30 cm)	N _{1(60),cs} :	Number of blows corrected for 60% energy and fines
C _N :	Overburden pressure factor	CRR _{7.5} :	Cyclic Resistance Ratio for M _w 7.50
C _E :	Energy ratio factor	F.S.:	Factor of safety against liquefaction

SPT BASED LIQUEFACTION ANALYSIS REPORT

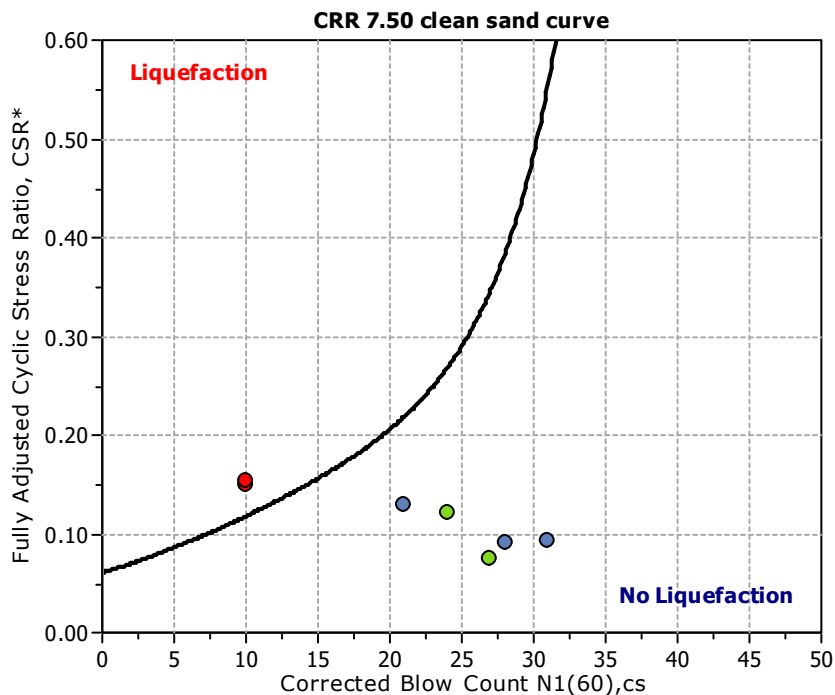
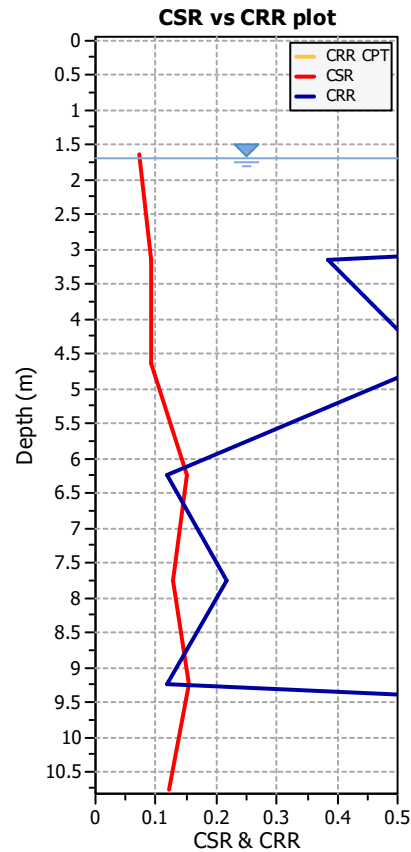
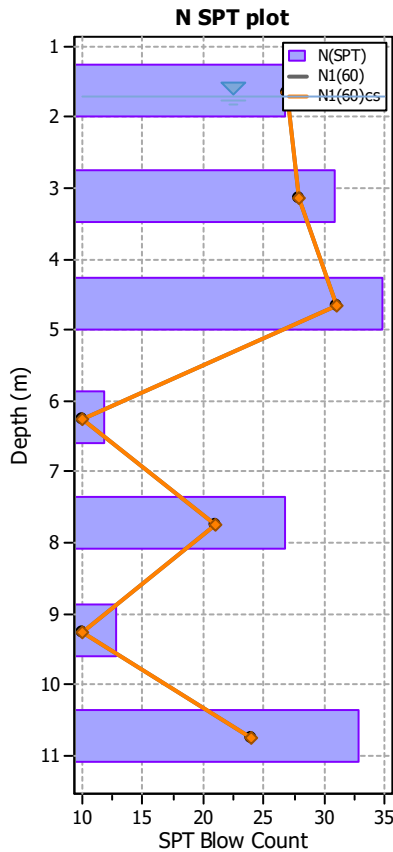
Project title : Liquefaction Assessment - 511185

Location : 518 Rangiora Woodend Road & 4 Golf Links Road

Borehole Name : BH06_SLS2

:: Input parameters and analysis properties ::

Analysis method:	Idriss & Boulanger 2014	G.W.T. (in-situ):	2.20	EQ site conditions:	Same as initial
Fines correction method:	Idriss & Boulanger 2014	G.W.T. (earthq.):	1.70		
Sampling method:	Standard Sample	Earthquake magnitude M_w :	6.00		
Borehole diameter:	65 mm to 11 5mm	Peak ground acceleration:	0.19		
Rod length:	1.50	SPT results rounding mode:	Nearest		
Hammer energy ratio:	0.82				



:: Cyclic Stress Ratio fully adjusted (CSR*) numeric results ::

No	Depth (m)	Weight (kN/m ³)	u ₀ (kPa)	σ _v (kPa)	Ext. Load (kPa)	σ' _v (kPa)	r _d	CSR	K _σ	MSF _{max}	MSF	CSR*
1	1.65	20.00	0.00	33.00	0.00	33.00	0.98	0.121	1.10	1.82	1.48	2.000
2	3.15	20.00	14.22	63.00	0.00	48.78	0.96	0.153	1.10	1.88	1.48	0.091
3	4.65	20.00	28.94	93.00	0.00	64.06	0.93	0.166	1.10	2.06	1.48	0.092
4	6.25	20.00	44.64	125.00	0.00	80.36	0.89	0.171	1.02	1.19	1.48	0.150
5	7.75	20.00	59.35	155.00	0.00	95.65	0.85	0.171	1.01	1.53	1.48	0.128
6	9.25	19.00	74.07	183.50	0.00	109.43	0.82	0.169	0.99	1.19	1.48	0.153
7	10.75	20.00	88.78	213.50	0.00	124.72	0.78	0.165	0.97	1.67	1.48	2.000

Abbreviations

- Depth: Depth from free surface where SPT was performed (m) during eq.
- u₀: Water pressure at test point (kPa) during eq.
- σ_v: Total overburden pressure at test point (kPa) during eq.
- σ'_v: Effective overburden pressure based on GWT during earthquake (kPa) during eq.
- r_d: Nonlinear shear mass factor
- CSR: Cyclic Stress Ratio
- MSF: Effective overburden stress factor
- K_σ: Magnitude Scaling Factor
- CSR*: CSR fully adjusted

:: Cyclic Resistance Ratio (CRR) numeric results ::

No	Depth (m)	Fines %	u ₀ (kPa)	σ _v (kPa)	σ' _v (kPa)	N _{SPT}	C _N	C _R	C _B	C _S	C _E	N ₁₍₆₀₎	Δ(N ₁) ₆₀	N _{1(60),cs}	CRR _{7.5}	F.S.
1	1.65	0.00	0.00	33.00	33.00	27	1.53	0.80	1.00	1.00	0.82	27	0.00	27	4.000	2.00
2	3.15	0.00	9.32	63.00	53.68	31	1.27	0.85	1.00	1.00	0.82	28	0.00	28	0.384	2.00
3	4.65	0.00	24.03	93.00	68.97	35	1.15	0.95	1.00	1.00	0.82	31	0.00	31	0.555	2.00
4	6.25	0.00	39.73	125.00	85.27	12	1.10	0.95	1.00	1.00	0.82	10	0.00	10	0.118	0.79
5	7.75	0.00	54.45	155.00	100.55	27	1.00	0.95	1.00	1.00	0.82	21	0.00	21	0.219	1.70
6	9.25	1.50	69.16	183.50	114.34	13	0.94	1.00	1.00	1.00	0.82	10	0.00	10	0.118	0.77
7	10.75	0.00	83.88	213.50	129.62	33	0.90	1.00	1.00	1.00	0.82	24	0.00	24	4.000	2.00

Abbreviations

- Depth: Depth from free surface where SPT was performed (m)
- Weight: Soil unit weight from previous test point to current (kN/m³)
- u₀: Water pressure at test point (kPa)
- σ_v: Total overburden pressure at test point (kPa)
- σ'_v: Effective overburden pressure based on in situ GWT (kPa)
- N_{SPT}: Number of blows count in the field (blows/30 cm)
- C_N: Overburden pressure factor
- C_E: Energy ratio factor
- C_B: Borehole diameter factor
- C_R: Rod length factor
- C_S: Sampling method factor
- N₁₍₆₀₎: Number of blows corrected for 60% energy
- ΔN_{1(60),cs}: Fines correction
- N_{1(60),cs}: Number of blows corrected for 60% energy and fines
- CRR_{7.5}: Cyclic Resistance Ratio for M_w 7.50
- F.S.: Factor of safety against liquefaction

SPT BASED LIQUEFACTION ANALYSIS REPORT

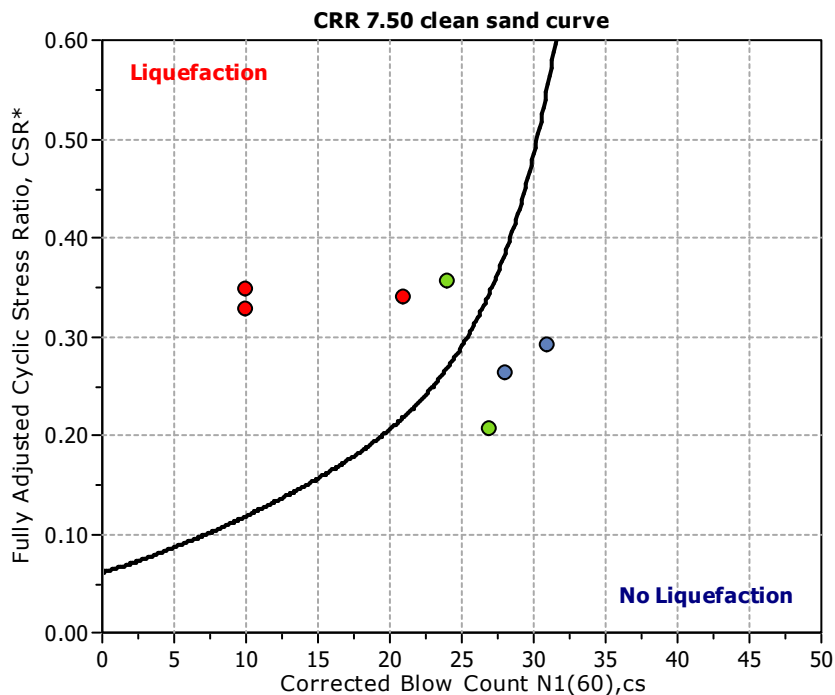
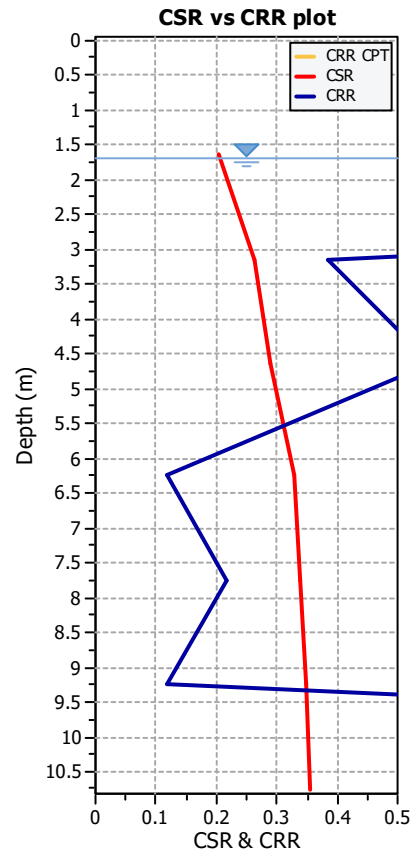
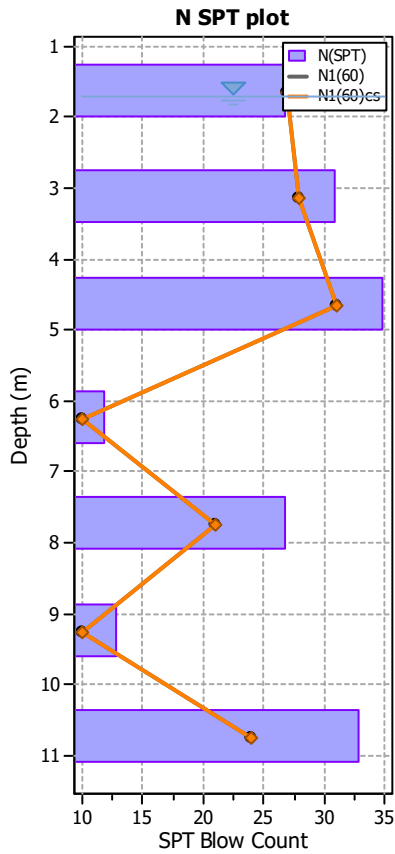
Project title : Liquefaction Assessment - 511185

Location : 518 Rangiora Woodend Road & 4 Golf Links Road

Borehole Name : BH06_ULS

:: Input parameters and analysis properties ::

Analysis method:	Idriss & Boulanger 2014	G.W.T. (in-situ):	2.20	EQ site conditions:	Same as initial
Fines correction method:	Idriss & Boulanger 2014	G.W.T. (earthq.):	1.70		
Sampling method:	Standard Sample	Earthquake magnitude M_w :	7.50		
Borehole diameter:	65 mm to 11 5mm	Peak ground acceleration:	0.35		
Rod length:	1.50	SPT results rounding mode:	Nearest		
Hammer energy ratio:	0.82				



:: Cyclic Stress Ratio fully adjusted (CSR*) numeric results ::												
No	Depth (m)	Weight (kN/m ³)	u ₀ (kPa)	σ _v (kPa)	Ext. Load (kPa)	σ' _v (kPa)	r _d	CSR	K _σ	MSF _{max}	MSF	CSR*
1	1.65	20.00	0.00	33.00	0.00	33.00	0.99	0.226	1.10	1.82	1.00	2.000
2	3.15	20.00	14.22	63.00	0.00	48.78	0.98	0.288	1.10	1.88	1.00	0.262
3	4.65	20.00	28.94	93.00	0.00	64.06	0.96	0.319	1.10	2.06	1.00	0.291
4	6.25	20.00	44.64	125.00	0.00	80.36	0.95	0.335	1.02	1.19	1.00	0.328
5	7.75	20.00	59.35	155.00	0.00	95.65	0.93	0.342	1.01	1.53	1.00	0.339
6	9.25	19.00	74.07	183.50	0.00	109.43	0.91	0.346	0.99	1.19	1.00	0.348
7	10.75	20.00	88.78	213.50	0.00	124.72	0.89	0.345	0.97	1.67	1.00	2.000

Abbreviations

- Depth: Depth from free surface where SPT was performed (m) during eq.
- u₀: Water pressure at test point (kPa) during eq.
- σ_v: Total overburden pressure at test point (kPa) during eq.
- σ'_v: Effective overburden pressure based on GWT during earthquake (kPa) during eq.
- r_d: Nonlinear shear mass factor
- CSR: Cyclic Stress Ratio
- MSF: Effective overburden stress factor
- K_σ: Magnitude Scaling Factor
- CSR*: CSR fully adjusted

:: Cyclic Resistance Ratio (CRR) numeric results ::																
No	Depth (m)	Fines %	u ₀ (kPa)	σ _v (kPa)	σ' _v (kPa)	N _{SPT}	C _N	C _R	C _B	C _S	C _E	N ₁₍₆₀₎	Δ(N ₁) ₆₀	N _{1(60),cs}	CRR _{7.5}	F.S.
1	1.65	0.00	0.00	33.00	33.00	27	1.53	0.80	1.00	1.00	0.82	27	0.00	27	4.000	2.00
2	3.15	0.00	9.32	63.00	53.68	31	1.27	0.85	1.00	1.00	0.82	28	0.00	28	0.384	1.46
3	4.65	0.00	24.03	93.00	68.97	35	1.15	0.95	1.00	1.00	0.82	31	0.00	31	0.555	1.91
4	6.25	0.00	39.73	125.00	85.27	12	1.10	0.95	1.00	1.00	0.82	10	0.00	10	0.118	0.36
5	7.75	0.00	54.45	155.00	100.55	27	1.00	0.95	1.00	1.00	0.82	21	0.00	21	0.219	0.64
6	9.25	1.50	69.16	183.50	114.34	13	0.94	1.00	1.00	1.00	0.82	10	0.00	10	0.118	0.34
7	10.75	0.00	83.88	213.50	129.62	33	0.90	1.00	1.00	1.00	0.82	24	0.00	24	4.000	2.00

Abbreviations

- Depth: Depth from free surface where SPT was performed (m)
- Weight: Soil unit weight from previous test point to current (kN/m³)
- u₀: Water pressure at test point (kPa)
- σ_v: Total overburden pressure at test point (kPa)
- σ'_v: Effective overburden pressure based on in situ GWT (kPa)
- N_{SPT}: Number of blows count in the field (blows/30 cm)
- C_N: Overburden pressure factor
- C_E: Energy ratio factor
- C_B: Borehole diameter factor
- C_R: Rod length factor
- C_S: Sampling method factor
- N₁₍₆₀₎: Number of blows corrected for 60% energy
- ΔN_{1(60),cs}: Fines correction
- N_{1(60),cs}: Number of blows corrected for 60% energy and fines
- CRR_{7.5}: Cyclic Resistance Ratio for M_w 7.50
- F.S.: Factor of safety against liquefaction

SPT BASED LIQUEFACTION ANALYSIS REPORT

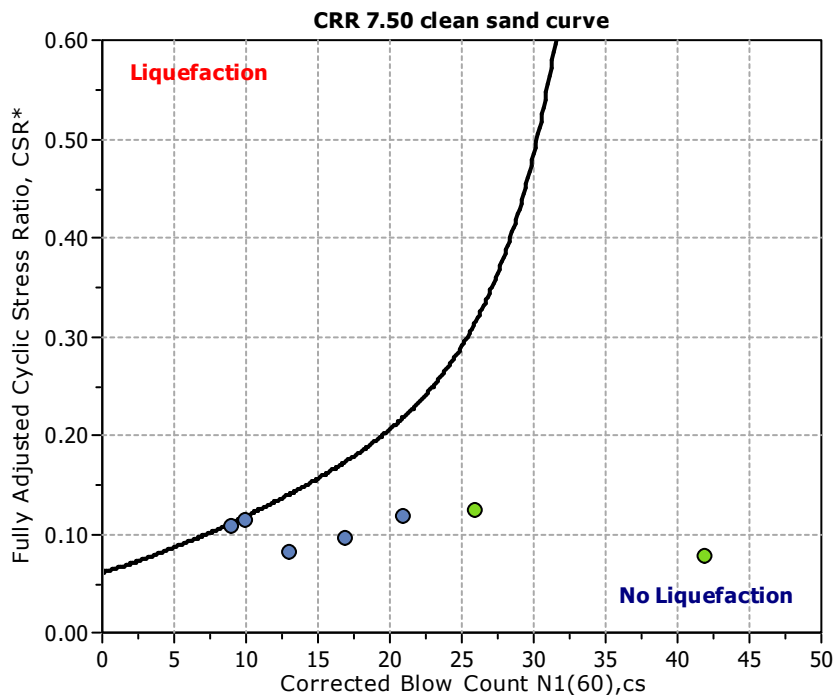
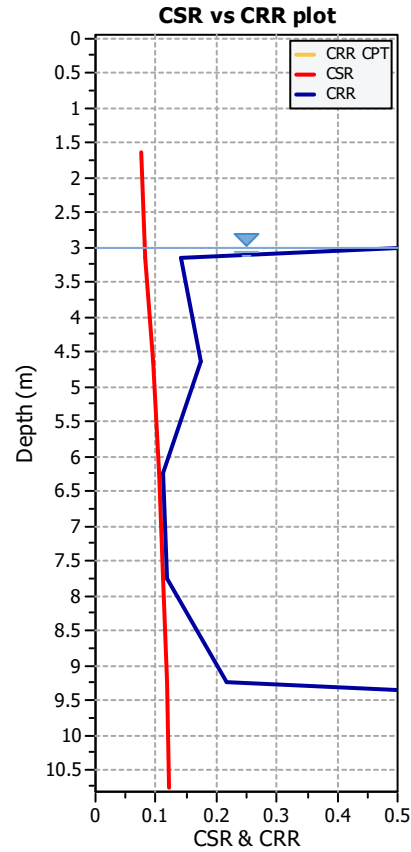
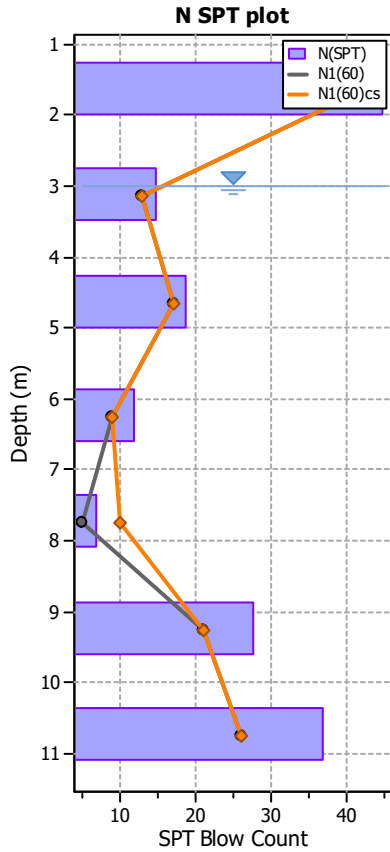
Project title : Liquefaction Assessment - 511185

Location : 518 Rangiora Woodend Road & 4 Golf Links Road

Borehole Name : BH07_SLS1

:: Input parameters and analysis properties ::

Analysis method:	Idriss & Boulanger 2014	G.W.T. (in-situ):	3.50	EQ site conditions:	Same as initial
Fines correction method:	Idriss & Boulanger 2014	G.W.T. (earthq.):	3.00		
Sampling method:	Standard Sample	Earthquake magnitude M_w :	7.50		
Borehole diameter:	65 mm to 115 mm	Peak ground acceleration:	0.13		
Rod length:	1.50	SPT results rounding mode:	Nearest		
Hammer energy ratio:	0.82				



:: Cyclic Stress Ratio fully adjusted (CSR*) numeric results ::												
No	Depth (m)	Weight (kN/m ³)	u ₀ (kPa)	σ _v (kPa)	Ext. Load (kPa)	σ' _v (kPa)	r _d	CSR	K _σ	MSF _{max}	MSF	CSR*
1	1.65	20.00	0.00	33.00	0.00	33.00	0.99	0.084	1.10	2.20	1.00	2.000
2	3.15	20.00	1.47	63.00	0.00	61.53	0.98	0.085	1.05	1.26	1.00	0.081
3	4.65	20.00	16.19	93.00	0.00	76.81	0.96	0.099	1.03	1.38	1.00	0.096
4	6.25	20.00	31.88	125.00	0.00	93.12	0.95	0.107	1.01	1.17	1.00	0.107
5	7.75	19.00	46.60	153.50	0.00	106.90	0.93	0.112	0.99	1.19	1.00	0.113
6	9.25	20.00	61.31	183.50	0.00	122.19	0.91	0.115	0.97	1.53	1.00	0.118
7	10.75	20.00	76.03	213.50	0.00	137.47	0.89	0.116	0.95	1.77	1.00	2.000

Abbreviations

- Depth: Depth from free surface where SPT was performed (m) during eq.
- u₀: Water pressure at test point (kPa) during eq.
- σ_v: Total overburden pressure at test point (kPa) during eq.
- σ'_v: Effective overburden pressure based on GWT during earthquake (kPa) during eq.
- r_d: Nonlinear shear mass factor
- CSR: Cyclic Stress Ratio
- MSF: Effective overburden stress factor
- K_σ: Magnitude Scaling Factor
- CSR*: CSR fully adjusted

:: Cyclic Resistance Ratio (CRR) numeric results ::																
No	Depth (m)	Fines %	u ₀ (kPa)	σ _v (kPa)	σ' _v (kPa)	N _{SPT}	C _N	C _R	C _B	C _S	C _E	N ₁₍₆₀₎	Δ(N ₁) ₆₀	N _{1(60),cs}	CRR _{7.5}	F.S.
1	1.65	2.40	0.00	33.00	33.00	45	1.39	0.80	1.00	1.00	0.82	42	0.00	42	4.000	2.00
2	3.15	0.00	0.00	63.00	63.00	15	1.27	0.85	1.00	1.00	0.82	13	0.00	13	0.140	1.74
3	4.65	0.00	11.28	93.00	81.72	19	1.11	0.95	1.00	1.00	0.82	17	0.00	17	0.174	1.82
4	6.25	0.00	26.98	125.00	98.02	12	1.02	0.95	1.00	1.00	0.82	9	0.00	9	0.111	1.04
5	7.75	27.60	41.69	153.50	111.81	7	0.95	0.95	1.00	1.00	0.82	5	5.25	10	0.118	1.04
6	9.25	0.00	56.41	183.50	127.09	28	0.91	1.00	1.00	1.00	0.82	21	0.00	21	0.219	1.85
7	10.75	0.00	71.12	213.50	142.38	37	0.88	1.00	1.00	1.00	0.82	26	0.00	26	4.000	2.00

Abbreviations

- Depth: Depth from free surface where SPT was performed (m)
- Weight: Soil unit weight from previous test point to current (kN/m³)
- u₀: Water pressure at test point (kPa)
- σ_v: Total overburden pressure at test point (kPa)
- σ'_v: Effective overburden pressure based on in situ GWT (kPa)
- N_{SPT}: Number of blows count in the field (blows/30 cm)
- C_N: Overburden pressure factor
- C_E: Energy ratio factor
- C_B: Borehole diameter factor
- C_R: Rod length factor
- C_S: Sampling method factor
- N₁₍₆₀₎: Number of blows corrected for 60% energy
- ΔN_{1(60),cs}: Fines correction
- N_{1(60),cs}: Number of blows corrected for 60% energy and fines
- CRR_{7.5}: Cyclic Resistance Ratio for M_w 7.50
- F.S.: Factor of safety against liquefaction

SPT BASED LIQUEFACTION ANALYSIS REPORT

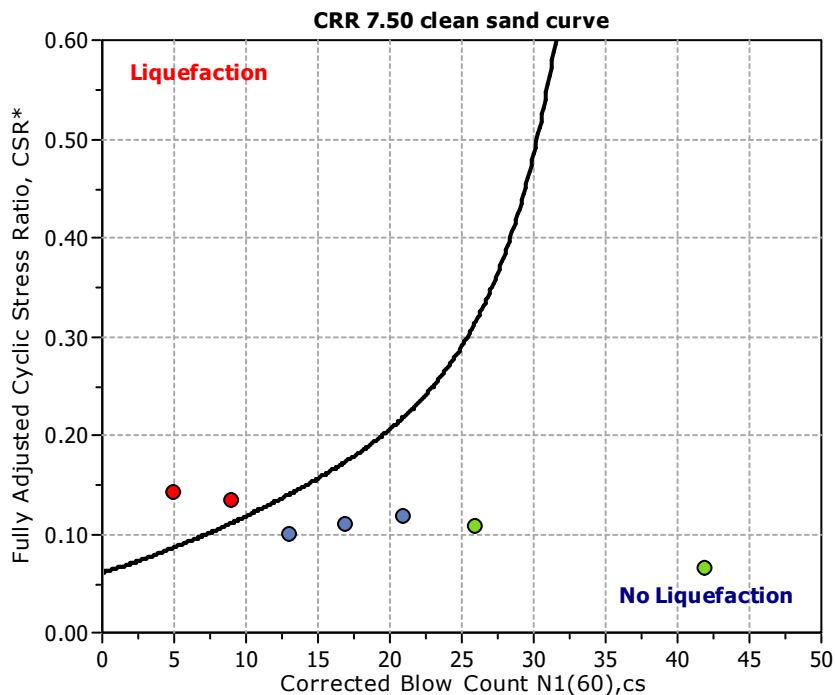
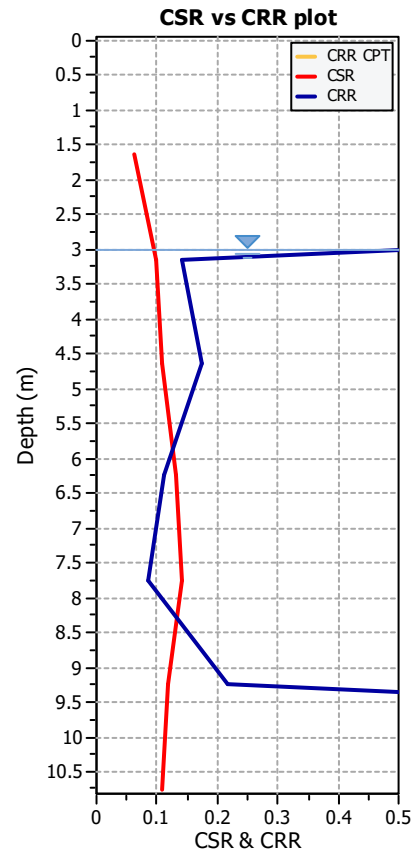
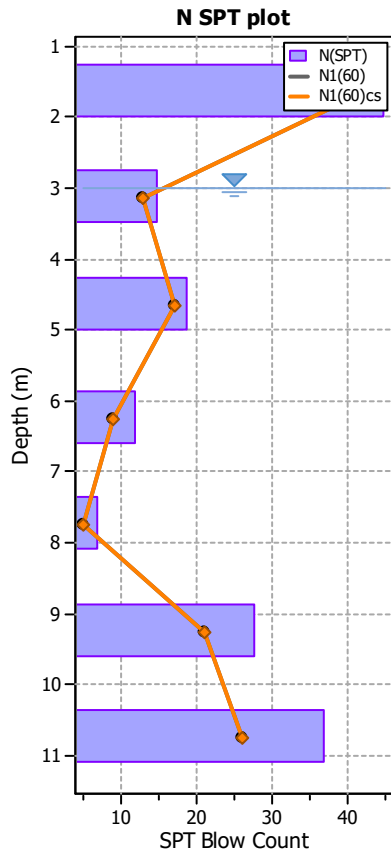
Project title : Liquefaction Assessment - 511185

Location : 518 Rangiora Woodend Road & 4 Golf Links Road

Borehole Name : BH07_SLS2

:: Input parameters and analysis properties ::

Analysis method:	Idriss & Boulanger 2014	G.W.T. (in-situ):	3.50	EQ site conditions:	Same as initial
Fines correction method:	Idriss & Boulanger 2014	G.W.T. (earthq.):	3.00		
Sampling method:	Standard Sample	Earthquake magnitude M_w :	6.00		
Borehole diameter:	65 mm to 115 mm	Peak ground acceleration:	0.19		
Rod length:	1.50	SPT results rounding mode:	Nearest		
Hammer energy ratio:	0.82				



:: Cyclic Stress Ratio fully adjusted (CSR*) numeric results ::												
No	Depth (m)	Weight (kN/m ³)	u ₀ (kPa)	σ _v (kPa)	Ext. Load (kPa)	σ' _v (kPa)	r _d	CSR	K _σ	MSF _{max}	MSF	CSR*
1	1.65	20.00	0.00	33.00	0.00	33.00	0.98	0.121	1.10	2.20	1.48	2.000
2	3.15	20.00	1.47	63.00	0.00	61.53	0.96	0.121	1.05	1.26	1.48	0.099
3	4.65	20.00	16.19	93.00	0.00	76.81	0.93	0.138	1.03	1.38	1.48	0.109
4	6.25	20.00	31.88	125.00	0.00	93.12	0.89	0.148	1.01	1.17	1.48	0.133
5	7.75	19.00	46.60	153.50	0.00	106.90	0.85	0.152	1.00	1.12	1.48	0.142
6	9.25	20.00	61.31	183.50	0.00	122.19	0.82	0.152	0.97	1.53	1.48	0.118
7	10.75	20.00	76.03	213.50	0.00	137.47	0.78	0.150	0.95	1.77	1.48	2.000

Abbreviations

- Depth: Depth from free surface where SPT was performed (m) during eq.
- u₀: Water pressure at test point (kPa) during eq.
- σ_v: Total overburden pressure at test point (kPa) during eq.
- σ'_v: Effective overburden pressure based on GWT during earthquake (kPa) during eq.
- r_d: Nonlinear shear mass factor
- CSR: Cyclic Stress Ratio
- MSF: Effective overburden stress factor
- K_σ: Magnitude Scaling Factor
- CSR*: CSR fully adjusted

:: Cyclic Resistance Ratio (CRR) numeric results ::																
No	Depth (m)	Fines %	u ₀ (kPa)	σ _v (kPa)	σ' _v (kPa)	N _{SPT}	C _N	C _R	C _B	C _S	C _E	N ₁₍₆₀₎	Δ(N ₁) ₆₀	N _{1(60),cs}	CRR _{7.5}	F.S.
1	1.65	2.40	0.00	33.00	33.00	45	1.39	0.80	1.00	1.00	0.82	42	0.00	42	4.000	2.00
2	3.15	0.00	0.00	63.00	63.00	15	1.27	0.85	1.00	1.00	0.82	13	0.00	13	0.140	1.41
3	4.65	0.00	11.28	93.00	81.72	19	1.11	0.95	1.00	1.00	0.82	17	0.00	17	0.174	1.60
4	6.25	0.00	26.98	125.00	98.02	12	1.02	0.95	1.00	1.00	0.82	9	0.00	9	0.111	0.84
5	7.75	7.60	41.69	153.50	111.81	7	0.94	0.95	1.00	1.00	0.82	5	0.26	5	0.086	0.61
6	9.25	0.00	56.41	183.50	127.09	28	0.91	1.00	1.00	1.00	0.82	21	0.00	21	0.219	1.86
7	10.75	0.00	71.12	213.50	142.38	37	0.88	1.00	1.00	1.00	0.82	26	0.00	26	4.000	2.00

Abbreviations

- Depth: Depth from free surface where SPT was performed (m)
- Weight: Soil unit weight from previous test point to current (kN/m³)
- u₀: Water pressure at test point (kPa)
- σ_v: Total overburden pressure at test point (kPa)
- σ'_v: Effective overburden pressure based on in situ GWT (kPa)
- N_{SPT}: Number of blows count in the field (blows/30 cm)
- C_N: Overburden pressure factor
- C_E: Energy ratio factor
- C_B: Borehole diameter factor
- C_R: Rod length factor
- C_S: Sampling method factor
- N₁₍₆₀₎: Number of blows corrected for 60% energy
- ΔN_{1(60),cs}: Fines correction
- N_{1(60),cs}: Number of blows corrected for 60% energy and fines
- CRR_{7.5}: Cyclic Resistance Ratio for M_w 7.50
- F.S.: Factor of safety against liquefaction

SPT BASED LIQUEFACTION ANALYSIS REPORT

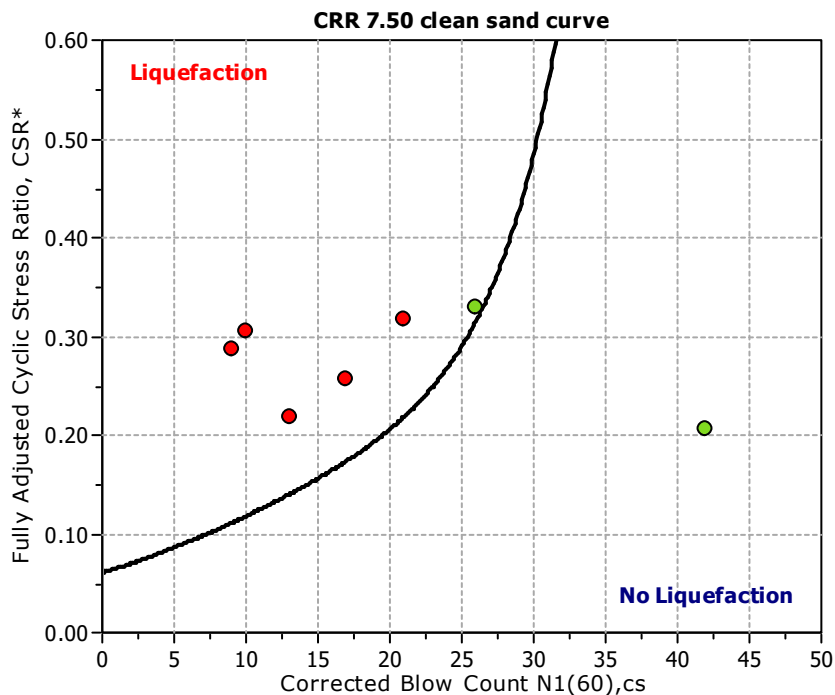
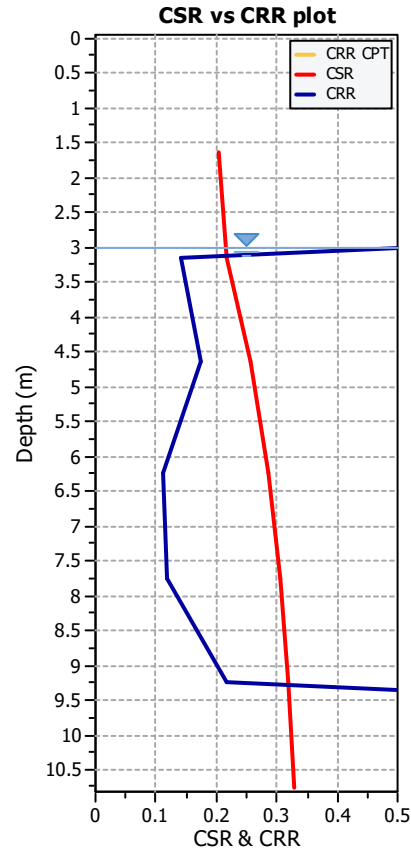
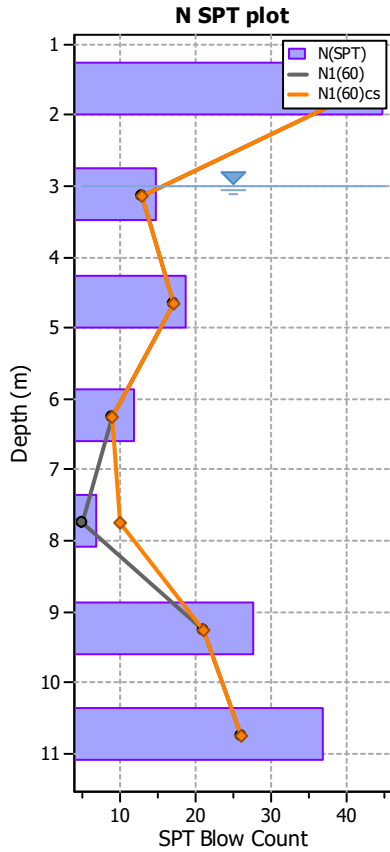
Project title : Liquefaction Assessment - 511185

Location : 518 Rangiora Woodend Road & 4 Golf Links Road

Borehole Name : BH07_ULS

:: Input parameters and analysis properties ::

Analysis method:	Idriss & Boulanger 2014	G.W.T. (in-situ):	3.50	EQ site conditions:	Same as initial
Fines correction method:	Idriss & Boulanger 2014	G.W.T. (earthq.):	3.00		
Sampling method:	Standard Sample	Earthquake magnitude M_w :	7.50		
Borehole diameter:	65 mm to 115 mm	Peak ground acceleration:	0.35		
Rod length:	1.50	SPT results rounding mode:	Nearest		
Hammer energy ratio:	0.82				



:: Cyclic Stress Ratio fully adjusted (CSR*) numeric results ::												
No	Depth (m)	Weight (kN/m ³)	u ₀ (kPa)	σ _v (kPa)	Ext. Load (kPa)	σ' _v (kPa)	r _d	CSR	K _σ	MSF _{max}	MSF	CSR*
1	1.65	20.00	0.00	33.00	0.00	33.00	0.99	0.226	1.10	2.20	1.00	2.000
2	3.15	20.00	1.47	63.00	0.00	61.53	0.98	0.228	1.05	1.26	1.00	0.217
3	4.65	20.00	16.19	93.00	0.00	76.81	0.96	0.266	1.03	1.38	1.00	0.257
4	6.25	20.00	31.88	125.00	0.00	93.12	0.95	0.289	1.01	1.17	1.00	0.287
5	7.75	19.00	46.60	153.50	0.00	106.90	0.93	0.303	0.99	1.19	1.00	0.304
6	9.25	20.00	61.31	183.50	0.00	122.19	0.91	0.310	0.97	1.53	1.00	0.318
7	10.75	20.00	76.03	213.50	0.00	137.47	0.89	0.313	0.95	1.77	1.00	2.000

Abbreviations

- Depth: Depth from free surface where SPT was performed (m) during eq.
- u₀: Water pressure at test point (kPa) during eq.
- σ_v: Total overburden pressure at test point (kPa) during eq.
- σ'_v: Effective overburden pressure based on GWT during earthquake (kPa) during eq.
- r_d: Nonlinear shear mass factor
- CSR: Cyclic Stress Ratio
- MSF: Effective overburden stress factor
- K_σ: Magnitude Scaling Factor
- CSR*: CSR fully adjusted

:: Cyclic Resistance Ratio (CRR) numeric results ::																
No	Depth (m)	Fines %	u ₀ (kPa)	σ _v (kPa)	σ' _v (kPa)	N _{SPT}	C _N	C _R	C _B	C _S	C _E	N ₁₍₆₀₎	Δ(N ₁) ₆₀	N _{1(60),cs}	CRR _{7.5}	F.S.
1	1.65	2.40	0.00	33.00	33.00	45	1.39	0.80	1.00	1.00	0.82	42	0.00	42	4.000	2.00
2	3.15	0.00	0.00	63.00	63.00	15	1.27	0.85	1.00	1.00	0.82	13	0.00	13	0.140	0.64
3	4.65	0.00	11.28	93.00	81.72	19	1.11	0.95	1.00	1.00	0.82	17	0.00	17	0.174	0.68
4	6.25	0.00	26.98	125.00	98.02	12	1.02	0.95	1.00	1.00	0.82	9	0.00	9	0.111	0.39
5	7.75	27.60	41.69	153.50	111.81	7	0.95	0.95	1.00	1.00	0.82	5	5.25	10	0.118	0.39
6	9.25	0.00	56.41	183.50	127.09	28	0.91	1.00	1.00	1.00	0.82	21	0.00	21	0.219	0.69
7	10.75	0.00	71.12	213.50	142.38	37	0.88	1.00	1.00	1.00	0.82	26	0.00	26	4.000	2.00

Abbreviations

- Depth: Depth from free surface where SPT was performed (m)
- Weight: Soil unit weight from previous test point to current (kN/m³)
- u₀: Water pressure at test point (kPa)
- σ_v: Total overburden pressure at test point (kPa)
- σ'_v: Effective overburden pressure based on in situ GWT (kPa)
- N_{SPT}: Number of blows count in the field (blows/30 cm)
- C_N: Overburden pressure factor
- C_E: Energy ratio factor
- C_B: Borehole diameter factor
- C_R: Rod length factor
- C_S: Sampling method factor
- N₁₍₆₀₎: Number of blows corrected for 60% energy
- ΔN_{1(60),cs}: Fines correction
- N_{1(60),cs}: Number of blows corrected for 60% energy and fines
- CRR_{7.5}: Cyclic Resistance Ratio for M_w 7.50
- F.S.: Factor of safety against liquefaction

SPT BASED LIQUEFACTION ANALYSIS REPORT

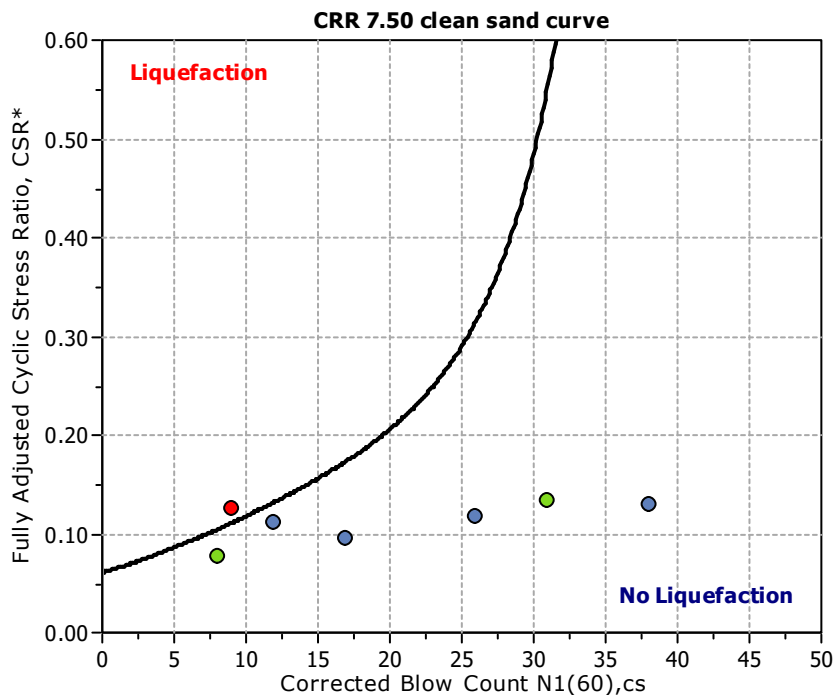
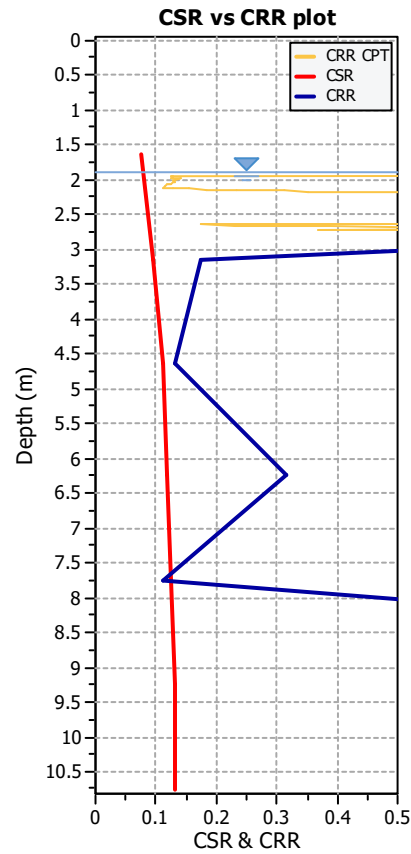
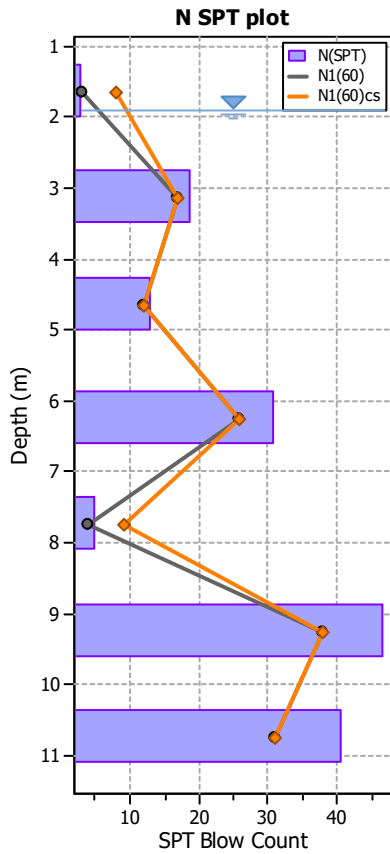
Project title : Liquefaction Assessment - 511185

Location : 518 Rangiora Woodend Road & 4 Golf Links Road

Borehole Name : BH08_SLS1

:: Input parameters and analysis properties ::

Analysis method:	Idriss & Boulanger 2014	G.W.T. (in-situ):	2.40	EQ site conditions:	Same as initial
Fines correction method:	Idriss & Boulanger 2014	G.W.T. (earthq.):	1.90		
Sampling method:	Standard Sample	Earthquake magnitude M_w :	7.50		
Borehole diameter:	65 mm to 115 mm	Peak ground acceleration:	0.13		
Rod length:	1.50	SPT results rounding mode:	Nearest		
Hammer energy ratio:	0.82				



:: Cyclic Stress Ratio fully adjusted (CSR*) numeric results ::												
No	Depth (m)	Weight (kN/m ³)	u ₀ (kPa)	σ _v (kPa)	Ext. Load (kPa)	σ' _v (kPa)	r _d	CSR	K _σ	MSF _{max}	MSF	CSR*
1	1.65	19.00	0.00	31.35	0.00	31.35	0.99	0.084	1.10	1.15	1.00	2.000
2	3.15	20.00	12.26	61.35	0.00	49.09	0.98	0.104	1.09	1.38	1.00	0.095
3	4.65	20.00	26.98	91.35	0.00	64.37	0.96	0.116	1.04	1.24	1.00	0.111
4	6.25	20.00	42.67	123.35	0.00	80.68	0.95	0.122	1.04	1.77	1.00	0.118
5	7.75	19.00	57.39	151.85	0.00	94.46	0.93	0.126	1.01	1.17	1.00	0.125
6	9.25	20.00	72.10	181.85	0.00	109.75	0.91	0.127	0.98	2.20	1.00	0.130
7	10.75	20.00	86.82	211.85	0.00	125.03	0.89	0.127	0.95	2.06	1.00	2.000

Abbreviations

- Depth: Depth from free surface where SPT was performed (m) during eq.
- u₀: Water pressure at test point (kPa) during eq.
- σ_v: Total overburden pressure at test point (kPa) during eq.
- σ'_v: Effective overburden pressure based on GWT during earthquake (kPa) during eq.
- r_d: Nonlinear shear mass factor
- CSR: Cyclic Stress Ratio
- MSF: Effective overburden stress factor
- K_σ: Magnitude Scaling Factor
- CSR*: CSR fully adjusted

:: Cyclic Resistance Ratio (CRR) numeric results ::																
No	Depth (m)	Fines %	u ₀ (kPa)	σ _v (kPa)	σ' _v (kPa)	N _{SPT}	C _N	C _R	C _B	C _S	C _E	N ₁₍₆₀₎	Δ(N ₁) ₆₀	N _{1(60),cs}	CRR _{7.5}	F.S.
1	1.65	22.66	0.00	31.35	31.35	3	1.70	0.80	1.00	1.00	0.82	3	4.85	8	4.000	2.00
2	3.15	2.49	7.36	61.35	53.99	19	1.34	0.85	1.00	1.00	0.82	17	0.00	17	0.174	1.82
3	4.65	0.00	22.07	91.35	69.28	13	1.22	0.95	1.00	1.00	0.82	12	0.00	12	0.132	1.20
4	6.25	0.00	37.77	123.35	85.58	31	1.07	0.95	1.00	1.00	0.82	26	0.00	26	0.316	2.00
5	7.75	27.60	52.48	151.85	99.37	5	1.01	0.95	1.00	1.00	0.82	4	5.25	9	0.111	0.89
6	9.25	0.00	67.20	181.85	114.65	47	0.96	1.00	1.00	1.00	0.82	38	0.00	38	2.273	2.00
7	10.75	0.00	81.91	211.85	129.94	41	0.92	1.00	1.00	1.00	0.82	31	0.00	31	4.000	2.00

Abbreviations

- Depth: Depth from free surface where SPT was performed (m)
- Weight: Soil unit weight from previous test point to current (kN/m³)
- u₀: Water pressure at test point (kPa)
- σ_v: Total overburden pressure at test point (kPa)
- σ'_v: Effective overburden pressure based on in situ GWT (kPa)
- N_{SPT}: Number of blows count in the field (blows/30 cm)
- C_N: Overburden pressure factor
- C_E: Energy ratio factor
- C_B: Borehole diameter factor
- C_R: Rod length factor
- C_S: Sampling method factor
- N₁₍₆₀₎: Number of blows corrected for 60% energy
- ΔN_{1(60),cs}: Fines correction
- N_{1(60),cs}: Number of blows corrected for 60% energy and fines
- CRR_{7.5}: Cyclic Resistance Ratio for M_w 7.50
- F.S.: Factor of safety against liquefaction

SPT BASED LIQUEFACTION ANALYSIS REPORT

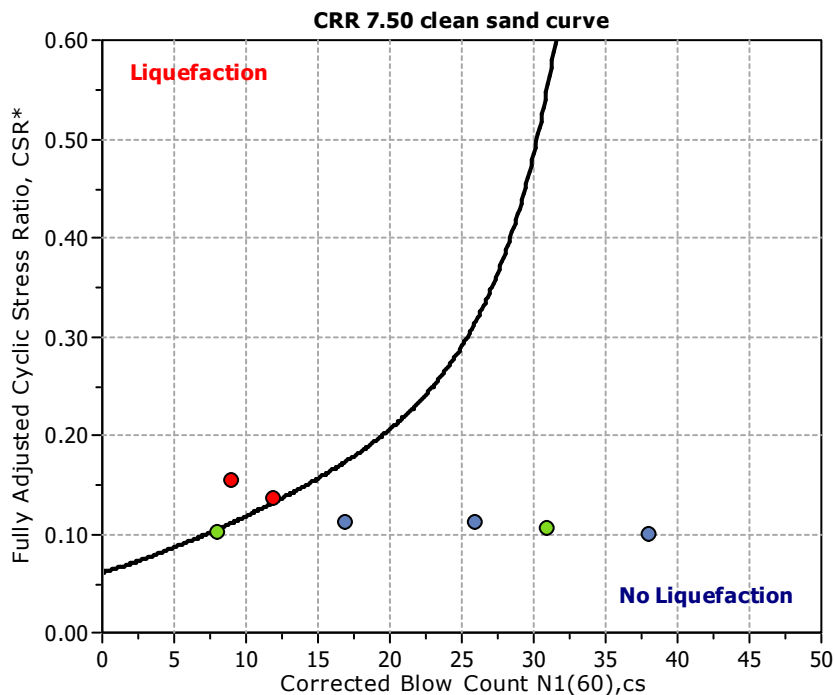
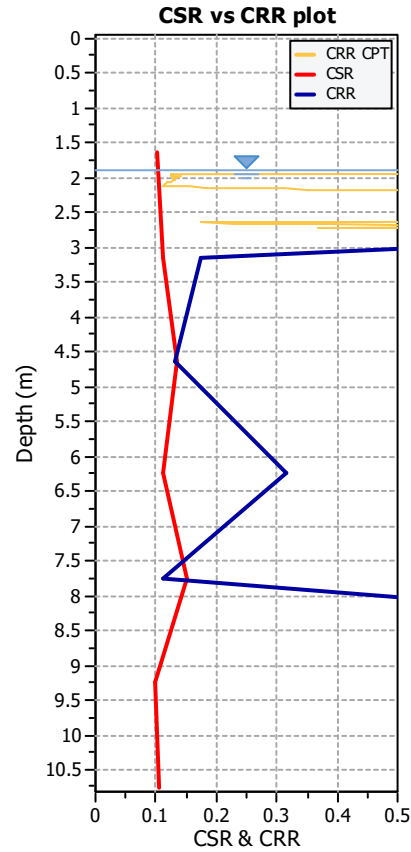
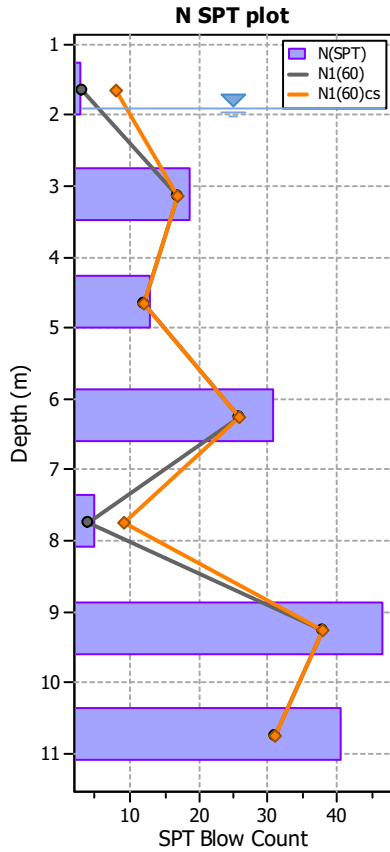
Project title : Liquefaction Assessment - 511185

Location : 518 Rangiora Woodend Road & 4 Golf Links Road

Borehole Name : BH08_SLS2

:: Input parameters and analysis properties ::

Analysis method:	Idriss & Boulanger 2014	G.W.T. (in-situ):	2.40	EQ site conditions:	Same as initial
Fines correction method:	Idriss & Boulanger 2014	G.W.T. (earthq.):	1.90		
Sampling method:	Standard Sample	Earthquake magnitude M_w :	6.00		
Borehole diameter:	65 mm to 115 mm	Peak ground acceleration:	0.19		
Rod length:	1.50	SPT results rounding mode:	Nearest		
Hammer energy ratio:	0.82				



:: Cyclic Stress Ratio fully adjusted (CSR*) numeric results ::												
No	Depth (m)	Weight (kN/m ³)	u ₀ (kPa)	σ _v (kPa)	Ext. Load (kPa)	σ' _v (kPa)	r _d	CSR	K _σ	MSF _{max}	MSF	CSR*
1	1.65	19.00	0.00	31.35	0.00	31.35	0.98	0.121	1.10	1.15	1.48	2.000
2	3.15	20.00	12.26	61.35	0.00	49.09	0.96	0.148	1.09	1.38	1.48	0.111
3	4.65	20.00	26.98	91.35	0.00	64.37	0.93	0.162	1.04	1.24	1.48	0.136
4	6.25	20.00	42.67	123.35	0.00	80.68	0.89	0.168	1.04	1.77	1.48	0.111
5	7.75	19.00	57.39	151.85	0.00	94.46	0.85	0.170	1.01	1.17	1.48	0.153
6	9.25	20.00	72.10	181.85	0.00	109.75	0.82	0.167	0.98	2.20	1.48	0.100
7	10.75	20.00	86.82	211.85	0.00	125.03	0.78	0.163	0.95	2.06	1.48	2.000

Abbreviations

- Depth: Depth from free surface where SPT was performed (m) during eq.
- u₀: Water pressure at test point (kPa) during eq.
- σ_v: Total overburden pressure at test point (kPa) during eq.
- σ'_v: Effective overburden pressure based on GWT during earthquake (kPa) during eq.
- r_d: Nonlinear shear mass factor
- CSR: Cyclic Stress Ratio
- MSF: Effective overburden stress factor
- K_σ: Magnitude Scaling Factor
- CSR*: CSR fully adjusted

:: Cyclic Resistance Ratio (CRR) numeric results ::																
No	Depth (m)	Fines %	u ₀ (kPa)	σ _v (kPa)	σ' _v (kPa)	N _{SPT}	C _N	C _R	C _B	C _S	C _E	N ₁₍₆₀₎	Δ(N ₁) ₆₀	N _{1(60),cs}	CRR _{7.5}	F.S.
1	1.65	22.66	0.00	31.35	31.35	3	1.70	0.80	1.00	1.00	0.82	3	4.85	8	4.000	2.00
2	3.15	2.49	7.36	61.35	53.99	19	1.34	0.85	1.00	1.00	0.82	17	0.00	17	0.174	1.57
3	4.65	0.00	22.07	91.35	69.28	13	1.22	0.95	1.00	1.00	0.82	12	0.00	12	0.132	0.97
4	6.25	0.00	37.77	123.35	85.58	31	1.07	0.95	1.00	1.00	0.82	26	0.00	26	0.316	2.00
5	7.75	27.60	52.48	151.85	99.37	5	1.01	0.95	1.00	1.00	0.82	4	5.25	9	0.111	0.73
6	9.25	0.00	67.20	181.85	114.65	47	0.96	1.00	1.00	1.00	0.82	38	0.00	38	2.273	2.00
7	10.75	0.00	81.91	211.85	129.94	41	0.92	1.00	1.00	1.00	0.82	31	0.00	31	4.000	2.00

Abbreviations

- Depth: Depth from free surface where SPT was performed (m)
- Weight: Soil unit weight from previous test point to current (kN/m³)
- u₀: Water pressure at test point (kPa)
- σ_v: Total overburden pressure at test point (kPa)
- σ'_v: Effective overburden pressure based on in situ GWT (kPa)
- N_{SPT}: Number of blows count in the field (blows/30 cm)
- C_N: Overburden pressure factor
- C_E: Energy ratio factor
- C_B: Borehole diameter factor
- C_R: Rod length factor
- C_S: Sampling method factor
- N₁₍₆₀₎: Number of blows corrected for 60% energy
- ΔN_{1(60),cs}: Fines correction
- N_{1(60),cs}: Number of blows corrected for 60% energy and fines
- CRR_{7.5}: Cyclic Resistance Ratio for M_w 7.50
- F.S.: Factor of safety against liquefaction

SPT BASED LIQUEFACTION ANALYSIS REPORT

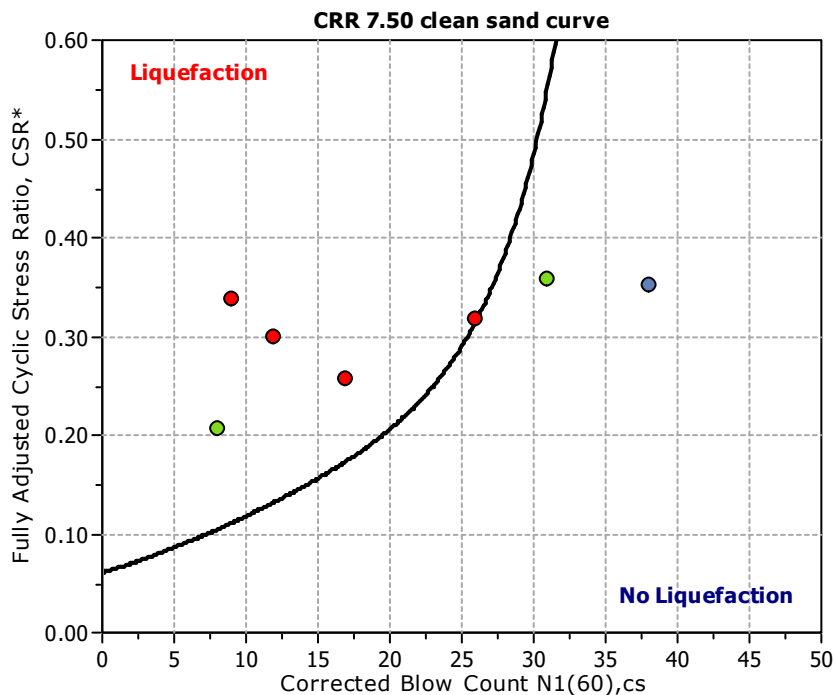
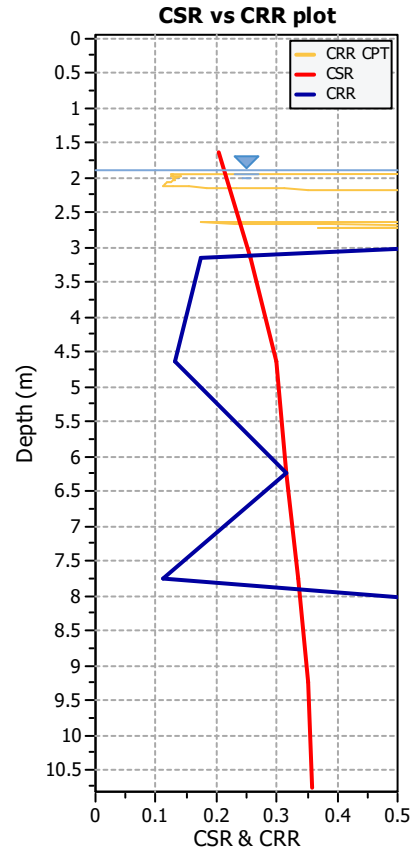
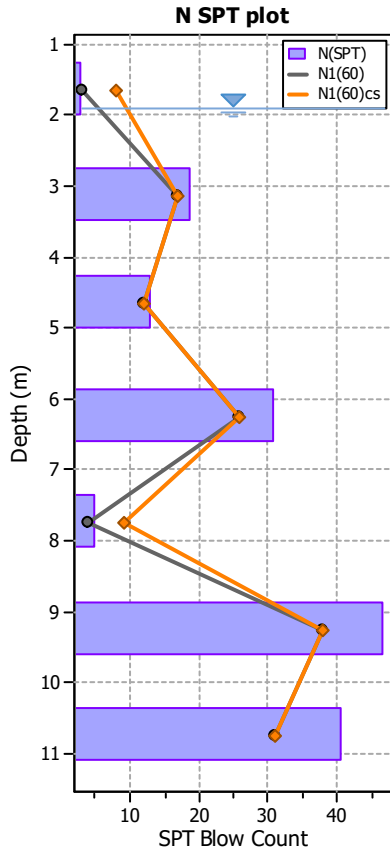
Project title : Liquefaction Assessment - 511185

Location : 518 Rangiora Woodend Road & 4 Golf Links Road

Borehole Name : BH08_ULS

:: Input parameters and analysis properties ::

Analysis method:	Idriss & Boulanger 2014	G.W.T. (in-situ):	2.40	EQ site conditions:	Same as initial
Fines correction method:	Idriss & Boulanger 2014	G.W.T. (earthq.):	1.90		
Sampling method:	Standard Sample	Earthquake magnitude M_w :	7.50		
Borehole diameter:	65 mm to 115 mm	Peak ground acceleration:	0.35		
Rod length:	1.50	SPT results rounding mode:	Nearest		
Hammer energy ratio:	0.82				



:: Cyclic Stress Ratio fully adjusted (CSR*) numeric results ::

No	Depth (m)	Weight (kN/m ³)	u ₀ (kPa)	σ _v (kPa)	Ext. Load (kPa)	σ' _v (kPa)	r _d	CSR	K _σ	MSF _{max}	MSF	CSR*
1	1.65	19.00	0.00	31.35	0.00	31.35	0.99	0.226	1.10	1.15	1.00	2.000
2	3.15	20.00	12.26	61.35	0.00	49.09	0.98	0.279	1.09	1.38	1.00	0.257
3	4.65	20.00	26.98	91.35	0.00	64.37	0.96	0.311	1.04	1.24	1.00	0.298
4	6.25	20.00	42.67	123.35	0.00	80.68	0.95	0.329	1.04	1.77	1.00	0.317
5	7.75	19.00	57.39	151.85	0.00	94.46	0.93	0.339	1.01	1.17	1.00	0.337
6	9.25	20.00	72.10	181.85	0.00	109.75	0.91	0.342	0.98	2.20	1.00	0.351
7	10.75	20.00	86.82	211.85	0.00	125.03	0.89	0.341	0.95	2.06	1.00	2.000

Abbreviations

- Depth: Depth from free surface where SPT was performed (m) during eq.
- u₀: Water pressure at test point (kPa) during eq.
- σ_v: Total overburden pressure at test point (kPa) during eq.
- σ'_v: Effective overburden pressure based on GWT during earthquake (kPa) during eq.
- r_d: Nonlinear shear mass factor
- CSR: Cyclic Stress Ratio
- MSF: Effective overburden stress factor
- K_σ: Magnitude Scaling Factor
- CSR*: CSR fully adjusted

:: Cyclic Resistance Ratio (CRR) numeric results ::

No	Depth (m)	Fines %	u ₀ (kPa)	σ _v (kPa)	σ' _v (kPa)	N _{SPT}	C _N	C _R	C _B	C _S	C _E	N ₁₍₆₀₎	Δ(N ₁) ₆₀	N _{1(60),cs}	CRR _{7.5}	F.S.
1	1.65	22.66	0.00	31.35	31.35	3	1.70	0.80	1.00	1.00	0.82	3	4.85	8	4.000	2.00
2	3.15	2.49	7.36	61.35	53.99	19	1.34	0.85	1.00	1.00	0.82	17	0.00	17	0.174	0.68
3	4.65	0.00	22.07	91.35	69.28	13	1.22	0.95	1.00	1.00	0.82	12	0.00	12	0.132	0.44
4	6.25	0.00	37.77	123.35	85.58	31	1.07	0.95	1.00	1.00	0.82	26	0.00	26	0.316	1.00
5	7.75	27.60	52.48	151.85	99.37	5	1.01	0.95	1.00	1.00	0.82	4	5.25	9	0.111	0.33
6	9.25	0.00	67.20	181.85	114.65	47	0.96	1.00	1.00	1.00	0.82	38	0.00	38	2.273	2.00
7	10.75	0.00	81.91	211.85	129.94	41	0.92	1.00	1.00	1.00	0.82	31	0.00	31	4.000	2.00

Abbreviations

- Depth: Depth from free surface where SPT was performed (m)
- Weight: Soil unit weight from previous test point to current (kN/m³)
- u₀: Water pressure at test point (kPa)
- σ_v: Total overburden pressure at test point (kPa)
- σ'_v: Effective overburden pressure based on in situ GWT (kPa)
- N_{SPT}: Number of blows count in the field (blows/30 cm)
- C_N: Overburden pressure factor
- C_E: Energy ratio factor
- C_B: Borehole diameter factor
- C_R: Rod length factor
- C_S: Sampling method factor
- N₁₍₆₀₎: Number of blows corrected for 60% energy
- ΔN_{1(60),cs}: Fines correction
- N_{1(60),cs}: Number of blows corrected for 60% energy and fines
- CRR_{7.5}: Cyclic Resistance Ratio for M_w 7.50
- F.S.: Factor of safety against liquefaction